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SLEEPING SICKNESS AND NAGANA

ELSEWHERE in this issue of *Nature* (p. 89), we are publishing a very brief statement under the names of the late Dr. F. H. S. Curd and Dr. D. G. Davey, of Imperial Chemical Industries, Ltd., relating to the new drug 'Antrycide'. This statement must be regarded as the scientific background of the Press conference held jointly by the Colonial Office and Imperial Chemical Industries, Ltd., on December 29.

From the work which has already been done with 'Antrycide', it appears to be of great value in the prophylaxis and cure of trypanosome diseases of cattle ; further, it has focused attention on one side of a very large and complex problem. In nearly all parts of tropical Africa tsetse flies (*Glossina*, of several species) prevail. These insects are the principal transmitters of the trypanosome infections of cattle, known generally as nagana, and the sole transmitters of human trypanosomiasis or sleeping sickness. The presence of tsetse flies generally renders it impossible to maintain cattle, and this prevents the development of mixed farming, or production of beef, and means that cultivation must be done by the human hand. There can be little doubt, also, that tsetse flies have presented a great barrier to transport, and therefore to the penetration of Africa by Arabs and Europeans. The problem is being attacked, and parts of it have been solved, by medical and veterinary workers, and by protozoologists and entomologists.

The entomological attack on tsetse has been by studying and attempting to alter the environment ; this has met with considerable success under certain conditions, particularly where the destruction of thickets has abolished the permanent haunts and breeding-places of some species of these flies. The method is now beginning to prove successful even against *Glossina morsitans*, a very widely distributed species and one which was particularly difficult to control. Some excellent ecology has been associated with this work : among other things, a method has been developed (based on marking individual flies, and determining the proportion of them in samples afterwards captured) of estimating the actual number of tsetse in an area. This quantitative work is of great value in studying the effect of bush-clearing on the fly community.

One way of attacking thicket and altering the environment so that it becomes unfavourable to the fly is by human settlement and cultivation. The method requires a good knowledge of the ecology of the African peasant, and a study of his agricultural methods. There are now areas in both east and west Africa in which large numbers of Africans, with their cattle, are living in health, where even a few years ago this was impossible. Another line of attack is by the destruction of game animals, a method which has proved to be successful against *G. morsitans* (though not against certain other species of tsetse which have sources of food other than the game). The scientific justification is that the trypanosomes which attack cattle live in the blood of many sorts of game animals, which constitute a reservoir. Moreover, certain sorts of tsetse are so dependent on ungulates for food, that if game is destroyed (cattle being absent) the tsetse die out. Game destruction has produced valuable results in Southern Rhodesia, where it seems that some ten thousand square miles have been cleared of tsetse at the low figure of about £18 to the square mile. It should not, however, be thought that other tsetse problems can be dealt with in the same way. The destruction of game, repugnant but necessary, entails also the duty and indeed the necessity of making reserves where stocks of the wild animals may be maintained for all time, completely segregated from cattle.

The use of insecticides is under study, and may prove valuable at least for special problems and in limited areas. The South Africans have had great success with a D.D.T. smoke, put down from the air, over a small game reserve. Nevertheless, it can scarcely be expected that insecticides will be a practical or economic way of tackling a fly-belt of thousands of square miles of unoccupied wilderness.

The trypanosome diseases of man, generally known as sleeping sickness, have been curable for many years. It is now customary for itinerant teams, mainly African, to visit villages where outbreaks occur, giving immediate treatment by injection, and there is seldom need to take the patients into hospital. Provided the work is thorough and the early cases are diagnosed and treated, this method reduces the likelihood of fresh infections, so that Health Departments are no longer afraid of epidemics and are steadily reducing the incidence of this disease. This represents an immense advance, the importance of which is not generally realized: for early in the present century, sleeping sickness, which was then incurable, was credited with the deaths of two-thirds of a population of about three hundred thousand in one part of Uganda, and was a frequent cause of depopulation in many parts of Africa. Certain drugs are also of great interest because they appear to give protection for some months, a factor which is of great value where men are exposed to particular risk.

The veterinary problem was until recently extremely difficult. The disease known generally as nagana can be caused by several species of trypanosome which react differently to drugs. One of these in particular, *Trypanosoma congolense*, is extremely dangerous to cattle and has been difficult to cure. Owing to the curative and protective effects of 'Antrycide', it seems likely that it will soon be possible to keep cattle in areas at present occupied by tsetse, or at least to move them through a fly belt on their way to market. A moment's reflexion will make it clear that the problem of treating large numbers of cattle which have never been handled and which range over large unfenced areas must be very difficult: and their owners, who are nomadic in many places, will have to be approached with understanding. Nevertheless, a way has been opened for attacking the central problem, and it must be expected that incidental difficulties will in due course be overcome.

The whole subject of trypanosomiasis, fascinating in its complexity, has been recently dealt with in a series of reports written by experts and published by the Colonial Office* The impression th
ceives from these reports is that fertile, acti
is progressing on many sides of the proble
certain conditions we can now conquer
and the infections which they transmit.
some hundreds of thousands of people,
cattle, living where they could not have liv
Still larger numbers have been protec
sleeping sickness by the use of drugs, and
it is possible to treat the cattle themselves
larger area will be available for developme

Summing up, trypanosomiasis of
probably of much more serious con
mankind than trypanosomiasis of
The fight against both these forms of
is waged on two broad fronts, against t
ting agent, the tsetse fly, on one hand,
the actual parasite, the trypanosome, on
Potentially, one of the most important w
the campaign aimed directly at the trypa
chemotherapy; but hitherto this has been
to a highly useful degree only against hu
not against animal, trypanosomiasis. Con
areas of tropical Africa are rendered safe fo
measures which include, as an essential fea
called mass prophylaxis and mass treatment,
enormous numbers of Africans are treated
established remedies for sleeping sickness.
on this scale has been possible hitherto ag
trypanosomiasis of domestic stock, largel
of the relative inefficacy, until recent
chemotherapeutic agents against the most
form of the disease affecting cattle, that
Trypanosoma congolense. Vast tracts of land
unsuitable for cattle raising, and this gives r
multitude of dependent evils, such as d
diseases due to low-grade protein dietary, a
impoverishment due to over-cultivation and
of the limited areas to which populations are co
as a result of the widespread incidence of tse
A big advance in the chemotherapy of *T. co*
infection in livestock came with the introduc
phenanthridinium compounds by Browning, M
Robb and Walls (*J. Path. Bact.*, 46, 203;
culminating in 'Phenanthridinium 1553', or 'Di
bromide'. The new compound named 'Ant
represents a further striking advance, one espe
valuable property of this substance being the
longed prophylactic period which is said to fol
single injection.

Once more, however, it is necessary to give w
against expecting immediate and widespread r
To treat cattle even on the scale necessary to pr
local improvement of diet and extension of agric
will not be an easy task; extending the trea
to whole areas of Africa will clearly be necessa
and is no doubt in mind—before any large-scal
effect on food-production or settlement can b
expected.

RP R-292

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* Colonial Office: The Anchau Rural Development and Settlemen
Scheme. By Dr. T. A. M. Nash. Pp. 22+4 plates. 3s. 6d. net. Try
panosomiasis in British West Africa. By Dr. T. H. Davey. Pp. 15
2s. net. Trypanosomiasis in Eastern Africa, 1947. By Prof. P.
Buxton. Pp. 44. 3s. net. Tsetse Flies in British West Africa.
Dr. T. A. M. Nash. Pp. 78+15 maps. 30s. net. (London: H.
Stationery Office, 1948.)

GEOLOGIST AND GEOGRAPHER IN EARLY NEW ZEALAND

e Life and Times of Sir Julius von Haast

plorer, Geologist, Museum Builder. By H. F. von ast. Pp. xxii + 1142 + 25 plates. (Wellington, : The Author, 41 Salamanca Road, 1948.)

N December 21, 1858, Julius Haast, a thirty-six- ar-old German, arrived in Auckland, New twenty-nine years later Sir Julius von M.G., F.R.S., died at Christchurch as one known men of science in the southern

of these twenty-nine years is one of n the point of view of the scientific, l civic development of New Zealand in lf-century of its existence as a self-govern- and tells of the advance of an unknown inence against the handicap of foreign birth at and against the constant opposition of on, who could see in geology no advantage unsurveyed and largely unexplored country, ed immediately to new goldfields or payable s.

Haast was not trained to be a geologist, he took some lectures in geology at the ty of Bonn, where he studied without ng. When he left the University he spent rs travelling in Europe engaged in some ed form of business activity, and in 1858 he a commission from an English firm of ship- o visit New Zealand to report upon the of a large-scale scheme for German emigra- hat colony.

e day following Haast's arrival in Auckland trian frigate *Novara* entered the port. The was on a scientific cruise around the world ied a large staff of scientific men, among them nd Hochstetter, then a member of the n Geological Survey, and later renowned as aniser and first director-general of the Imperial l History Museum in Vienna. Haast, feeling ely in a strange land, was delighted to meet llow countrymen, and soon struck up what to be a lifelong friendship with Hochstetter. he request of the New Zealand Government, etter was detached from the expedition in o make a survey of the mineral and other es of the colony. For nine months he toured provinces of Auckland and Nelson, and took t along with him. This was the turning point st's life, for under the influence of Hochstetter's siasm and expert knowledge, geology, which usly had only been Haast's hobby, became the nterest in his life. Business and emigration no interested him; he decided to be a geologist. y be remarked here that one of the marvels of s career is that, except for the nine months he with Hochstetter, he had no real training in gy. He learnt modern geology from text-books and kept himself up to date by scientific journals, all purchased from his own small salary—there were no scientific libraries in New Zealand in those days.

Six months after the departure of Hochstetter, aast made an offer to the Provincial Government of anterbury to make for it a topographical and ological survey of that Province. The offer was epted, but no formal agreement was drawn up; d what was intended to be an undertaking of two or three years duration became a major operation extending over a decade, in the course of which Haast ascended every Canterbury river to its source and mapped all the principal peaks of the Southern Alps, their outrunning spurs, their snowfields, glaciers and watercourses.

Haast was not a shy man and took, or made, every opportunity of corresponding with all the best-known geologists, botanists, glaciologists and zoologists of Europe and America—among his numerous correspondents in Great Britain alone were Murchison, Lyell, Tyndall, Hooker, Ramsay, Huxley and Darwin. This, however, was not surprising, for he had much to tell them which they wished to know. Little of the geology of the southern hemisphere was then known, and so his geological survey of a considerable area of New Zealand was welcomed by geologists. In his survey he found evidence of a former great expansion of the glaciers of the Southern Alps comparable with the extension in the European Alps during the Great Ice Age; this, with its implications of world-wide glaciation, was of intense interest to geographers and glaciologists. When a few years earlier Owen had described, on the evidence of a single bone, a gigantic wingless bird which had recently lived in New Zealand, the interest excited extended far beyond scientific circles. Subsequent discovery of further bones of the same species confirmed Owen, and naturally every zoologist and museum director desired to possess at least one moa bone. Haast discovered not single bones but literally heaps of them, so that he could construct complete skeletons, and these he offered to his correspondents in return for museum specimens which he himself desired. In his mapping of the Southern Alps many new peaks, glaciers and rivers required names; in the absence of native names Haast "commemorated, as in a mighty cenotaph of Nature, the great scientists of the nineteenth century, and so it comes about that we find upon the map of New Zealand the names of the world's representative scientists from all parts of the world". Practically every one of Haast's scientific correspondents was commemorated in this way, and one of his greatest pleasures was to inform a correspondent of the fact. There is no wonder that within ten years of becoming a geologist, Haast's name was well known in scientific circles.

We cannot here follow Haast's subsequent career in detail; but the book tells us how he took a leading part in establishing in the young colony new intellectual activities, especially in art, music and education; how he established and became director of the Canterbury Museum and made it by far the finest museum south of the equator; how he was sent to England in charge of the New Zealand exhibit at the Colonial and Indian Exhibition held in London in 1886 under the presidency of the Prince of Wales, and how his energy in organising the New Zealand Court so impressed the Prince that he personally suggested to Queen Victoria that she should invest Haast with the K.C.M.G.; and how Haast died within a month of his return from London, full of honours and the respect of the citizens of Christchurch, who had been so slow to recognize his abilities twenty years earlier.

The book is interestingly written by his son and will attract both scientific and non-scientific readers; it would, however, have been easier to read with enjoyment if it had not run to half a million words and had been less than four pounds in weight.

GEORGE C. SIMPSON

DAVID DOUGLAS: BOTANIST AND TRAVELLER

Douglas of the Fir

A Biography of David Douglas, Botanist. By Athelstan George Harvey. Pp. x+290+6 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1947.) 22*s.* net.

When a taxonomist describes some hitherto unrecognized form of life he is free to select what attributes he likes as the basis of the name by which the new organism shall be known—the specific name only, if he assigns it to an already established genus, and both generic and specific if it is different enough to warrant the setting up of a new genus. The name, in fact, reflects only the view of one individual as to what is appropriate, and it must be admitted that where such a name perpetuates the memory of a person, the person in question has often had very little real claim to such distinction. When, however, the common designation for a plant or animal includes a person's name, one expects to find that the person has had much to do with making the organism widely known and has probably also taken an active part in the general field of exploration and distribution. Douglas's name is attached to one of the finest and most important trees of the world, and one is ready to be interested in learning more about him. It was this interest that led the author of the book under review to undertake the collection of all traceable information about this enthusiastic exploring botanist and collector, who did so much some hundred and twenty years ago to discover and introduce to Europe the wealth of trees and plants of western America, particularly the Columbia basin.

David Douglas, whose Pacific Coast journeys were made between 1824 and his tragic death in Hawaii in 1834, was methodical in his habits, at least to the extent of keeping a diary, the surviving parts of which were published in 1914, extracts having already appeared in 1836 (through W. J. Hooker). His botanical enthusiasm, his pertinacity—doubly apparent when extra handicaps such as failing eyesight, an injured limb, or malnutrition had to be overcome—and his faculty for getting on with the local Indians, were his outstanding characteristics, and they brought him in a relatively few years from a humble origin to general recognition as the most successful man in Europe in his chosen field. His rugged individualism was an important factor in his success on his travels, but got him into difficulties at home; he must at times have been most aggravating to his companions, always wanting to do something different, usually something more difficult and more exhausting than necessary, such as walking when one could ride, or forcing a way through trailless riverside vegetation when one had a boat. His pertinacity and physical endurance never showed better than on the occasions when in fording rivers he lost the fruits of months of work, or equally in the way he carried on his back his specimens, dead and alive—for he was almost equally keen on animals, birds and rocks—sometimes hundreds of miles, perhaps only to lose them in the end to a predatory dog or rat.

To Douglas, the tree we know as his 'fir', or *Pseudotsuga taxifolia,* was a pine—to this day the timber is 'Oregon pine'—and pines were, perhaps, his greatest enthusiasm. His ultimately successful search after the sugar pine (*P. lambertiana*) is itself a botanical epic, and it would perhaps be more fitting if his name were associated with it rather than the *Pseudotsuga.* He also introduced another pine, which from a restricted distribution in Monterey, California, is now among the most important in forestry, namely, *P. insignis,* as well as *P. ponderosa. P. monticola* and *P. sabiana* were also discovered or introduced to Europe by him, not to mention Sitka spruce (as *P. menziesii*), *Abies nobilis* and *A. amabalis.* Incidentally, the Douglas fir was discovered by Capt. Vancouver in 1792 and described by Lambert in 1803 as *Pinus taxifolia.* Lambert, however, had no cones until Douglas brought him some, and then he described it as *P. douglasii.*

The biography is illustrated by portraits of David Douglas, his father, and W. J. Hooker, and five good photographs of the country he explored. The sketch maps could be a good deal better. There is a selected list of Douglas's introductions. The author had a quite exceptionally interesting subject for his study, and the story has not lost in the telling.

H. G. Champion

'POPULAR' ANIMAL BOOKS

Animal Wonderland

Essays in Natural History. By Frank W. Lane. Pp. xii + 232 + 80 plates. (London: Country Life, Ltd., 1948.) 15*s.* net.

Animals Alive

By Austin H. Clark. Pp. viii + 472. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 22*s.* net.

The two books "Animal Wonderland" and "Animals Alive", the first by Frank W. Lane and the second by Austin H. Clark, are not only alike in their titles but also in the wide field they cover. Both are of the type termed 'popular', that is to say they present the layman with a variety of interesting facts concerning creatures great and small in non-technical language. Dr. Clark sets out to survey the animal kingdom from mammals (including man) to insects, spiders and more lowly beings. He points out that some of the smallest creatures are not the least in importance to us, for example, such domesticated insects as the honeybee and the silkworm. His book is very readable, and full of reliable information.

Mr. Lane's book is also readable and entertaining. It is a collection of remarkable things concerning animals, culled from sources far and near. He begins with the "split second in Nature", and cites such facts as "a human sneeze rarely lasts more than a tenth of a second, and some of the droplets in a hearty sneeze are shot out at a speed of one hundred and fifty-two feet per second, or just over one hundred miles per hour". He goes on to such topics as "Accidental Death", one of the illustrations to which shows a pike choked by trying to swallow another pike not much smaller than itself; "Have Animals a Time Sense ?" and many others; the last chapter being devoted to "A Species that was Saved", namely, the North American bison, which after being nearly exterminated by the recklessness of hunters has been nursed back into a safe position—Mr. Lane says the 1933 figures showed a population of 21,701 bison.

Frances Pitt

Mother Earth

A Popular Account of the Earth in the Light of Recent Knowledge. By Dr. T. A. Ryder. Pp. 184. (London: Hutchinson's Scientific and Technical Publications, 1947.) 15*s.* net.

THIS book deals with earth sciences other than their applied aspects. It gives a general account of the origin, nature and features of the earth, its hydrosphere and atmosphere and a brief account of the solar system. Inevitably it covers much of the main field of text-books of physical geology and geography. No specialized knowledge is assumed, but technical terms have crept in here and there. It is designed to bring a wider appreciation of the more striking aspects of recent research, and is generally a well-balanced presentation.

There is a regrettably large number of misstatements which detracts from the merits of the book. The lithosphere is described as the discontinuous granitic layer, absent beneath the oceans, in one place (p. 29), and elsewhere as including a lower, basaltic portion (p. 35). Metamorphic rocks are described without reference to thermal effect (p. 30). Ammonites are not "almost invariably" an indication of Jurassic age (p. 32), nor do clays consist mainly of flakes of "alumina" (p. 37). The Yorkshire and Lincolnshire Wolds are not composed of Jurassic rocks (p. 46), nor are Mauna Loa and Mauna Kea in the Philippines! The repeated reference to "palæographic" meaning 'palæogeographic' maps is unfortunate. The summary on p. 114 is no summary at all. "Ocean deep" in one place refers to the ocean basins, and in another to the oceanic troughs, and so on. From this far from complete catalogue, and other minor errors in proof reading, it will be evident that the book must fall short seriously of the excellent intentions of the author. Nevertheless, it combines an outline of a wide range of interesting developments written for the layman and not readily obtainable in this form.

Life: its Nature and Origin

By Jerome Alexander. Pp. ix+291. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 30*s.* net.

THIS is an example of a 'semi-popular' book on science of a kind which seems to be characteristic of the United States. The field covered is adumbrated in the first two sentences of the preface: "The mystery of life, so long unsolved, and by many regarded as beyond human understanding, has been slowly revealing itself in the light of scientific investigation. The purpose of this book is to present in coherent order sufficient facts regarding material biological phenomena to show that life is dominated by *catalysis*—the direction of chemical change by surface areas of specific structure and efficiency." In pursuit of this aim the author wanders—alas, not very coherently—over a vast area which includes almost every topic from nuclear physics to modern psychology. He quotes rather extensively from detailed original papers, and certainly parades before his readers a huge and heterogeneous assemblage of facts and suppositions. But throughout most of the book, the theoretical structure which connects, say, a paragraph on the determination of the different castes in Hymenoptera with one on the recognition by rattlesnakes of their reptilian enemies amounts to no more than a repetition of the sentiment that here we have catalysis at work again. The book should have been pruned to half its size; its argument, which is by no means novel but probably worth stating clearly for a popular audience, would then have emerged much more forcibly.

C. H. WADDINGTON

Synthetische Methoden der organischen Chemie

Von W. Theilheimer. Repertorium 2. Pp. viii+309. (Basel and New York: S. Karger, 1948.) 35 Swiss francs.

ORGANIC chemists will welcome the appearance of this second volume of "Theilheimer", in which are to be found references to most of the more important synthetic reactions, old and new, described in the European literature for 1944–46. This limitation to European sources is due solely to war conditions and is to be remedied in a later volume in which the American literature, *inter alia*, will be dealt with. In all, 845 reactions are cited, and it is interesting to note that half are from the *Journal of the Chemical Society* and one-third from *Helvetica Chimica Acta*. The reactions are arranged according to a system which is simple and clearly explained; a good alphabetical index, which also covers the first volume, aids in the search for methods suitable for the synthesis of given types of compound. The information given under each reaction comprises the reference, supplemented if necessary by references to earlier key papers, and an outline of the experimental details.

The book is well produced, convenient in size and stoutly bound, an important feature in a volume likely to be consulted so frequently. There is little doubt that "Theilheimer" has come to stay as an important adjunct to "Beilstein" in the literature of organic chemistry.

H. N. RYDON

Dipole Moments

Their Measurement and Application in Chemistry. By Prof. R. J. W. Le Fèvre. (Methuen's Monographs on Physical Subjects.) Second edition, revised and reset. Pp. v+118. (London: Methuen and Co., Ltd., 1948.) 5*s.* net.

DR. LE FÈVRE has written a very lucid and useful little book that amply covers the subject-matter, as outlined by the title. The theory in Chapter 1 is clear and fairly simply presented, except perhaps in Debye's derivation of orientation polarization (leading to the Langevin function), where the mathematics is abbreviated and the Maxwell–Boltzmann distribution is used but not quoted as such; however, this compression may be intentional in such a slim volume. Chapter 2 gives all the necessary information required for the measurement of dielectric constants by a variety of methods and the calculation of results: the main criticism that might be offered here is that some of the instructions are too detailed; for example, in quoting the valve numbers of the author's electronic apparatus. Chapters 3, 5 and 6 on solvent effects, intra-molecular rotations and anomalous dipole moments respectively are all very comprehensive, but to the more general chemist the most interesting section of the book is Chapter 4. In this part a wide survey is made of the application of dipole moments to the solution of structural problems, and a large number of actual examples and papers are quoted and discussed.

Finally, this book is well indexed and full of references, and it certainly lives up to the high standard that we have come to expect of this series of little monographs.

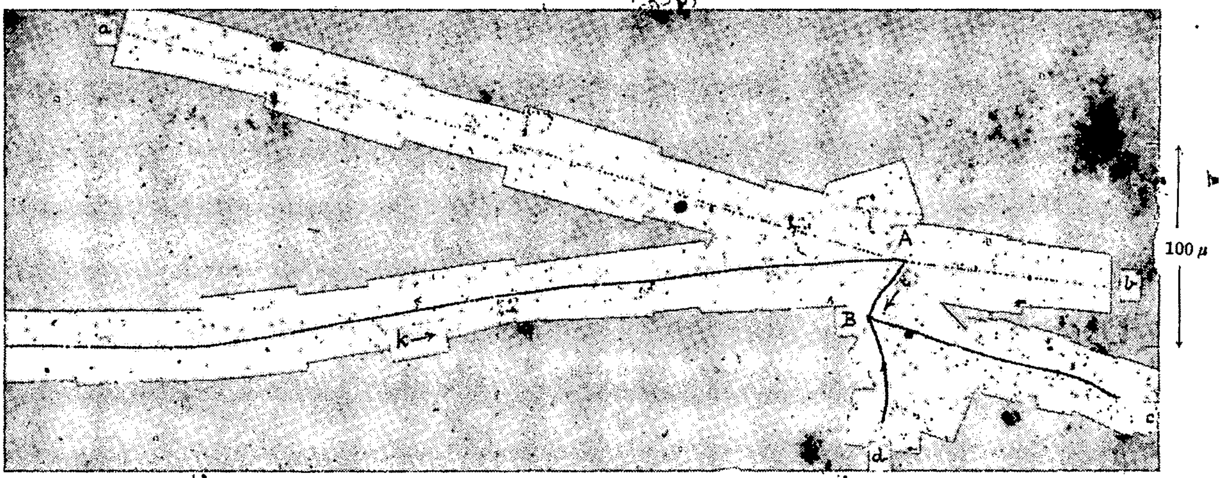
OBSERVATIONS WITH ELECTRON-SENSITIVE PLATES EXPOSED TO COSMIC RADIATION*

By Miss R. BROWN, U. CAMERINI, P. H. FOWLER, H. MUIRHEAD
and Prof. C. F. POWELL
H. H. Wills Physical Laboratory, University of Bristol

and D. M. RITSON
Clarendon Laboratory, Oxford

PART 2. FURTHER EVIDENCE FOR THE EXISTENCE OF UNSTABLE CHARGED PARTICLES, OF MASS ~ 1,000 m_e, AND OBSERVATIONS ON THEIR MODE OF DECAY

ONE of the first events found in the examination of electron-sensitive plates exposed at the Jungfraujoch is represented in the mosaic of photomicrographs shown in Fig. 8. There are two centres, *A* and *B*, from which the tracks of charged particles diverge, and these are joined by a common track, *t*. Because of the short duration of the exposure, and the small number of disintegrations occurring in the plate, the chance that the observation corresponds to a fortuitous juxtaposition of the tracks of unrelated events is very small—of the order 1 in 10^7. It is therefore reasonable to exclude it as a serious possibility. Further observations in support of this assumption are presented in a later paragraph.



Observer: Mrs. W. J. van der Merwe

Fig. 8

An inspection of the track *k* shows that the particle producing it approached the centre of disintegration *A*. The range of the particle in the emulsion exceeds 3,000 μ, and there is continuous increase in the grain-density along the track in approaching *A*. Near *A*, the grain-density is indistinguishable from that of particles of charge *e*, recorded in the same plate, near the end of their range.

The evidence for the direction of motion of the particle based on grain-counts is supported by observations on the small-angle deviations in the track due to Coulomb scattering. These deviations are most frequent near *A*, and the scattering is less marked at points remote from it.

From these observations, it is reasonable to conclude that the particle *k* approached the point *A*; that it carried the elementary electronic charge; and that it had reached, or was near, the end of its range at the point *A*. We therefore assume that the particle *k* initiated the train of events represented by the tracks radiating from *A* and *B*. It follows that the particle producing track *t* originated in star *A*, and produced the disintegration *B*. In order to analyse the event, we first attempted to determine the mass of the particle *k*.

Mass Determinations by Grain-Counts

About a year ago, experiments were made in this Laboratory to determine the ratio, m_π/m_μ, of the masses of π- and μ-mesons, by the method of grain-counting[5], and by studying the small-angle scattering of the particles in their passage through the emulsion[4]. The values obtained by the two methods were $m_\pi/m_\mu = 1\cdot65 \pm 0\cdot11$, and $m_\pi/m_\mu = 1\cdot35 \pm 0\cdot10$*, respectively. Recent experiments at Berkeley[6] suggest that the true value is $1\cdot33 \pm 0\cdot02$, a result which throws serious doubt on the reliability of the method based on grain-counts. Because of the advantage of this method, and of the important conclusions which have been based on it, experiments were made to determine the conditions in which reliable results can be obtained.

In the first experiments[5], the two most serious experimental difficulties arose from the fading of the latent image and from the variation of the degree of development with depth. This made it necessary to

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* Continued from page 51.

* For the following reasons, the limits of error quoted above, in the determination of m_π/m_μ by observations on scattering, are less than those given in ref. 4. Previously, values for the mass of the different types of mesons, classified phenomenologically, were given separately. It is now known, however, that at least the majority of the σ-mesons are π^--particles; and the ρ-mesons, μ^+- and μ^--particles. The different results can therefore be combined to give a value for m_π/m_μ with a greater statistical weight.

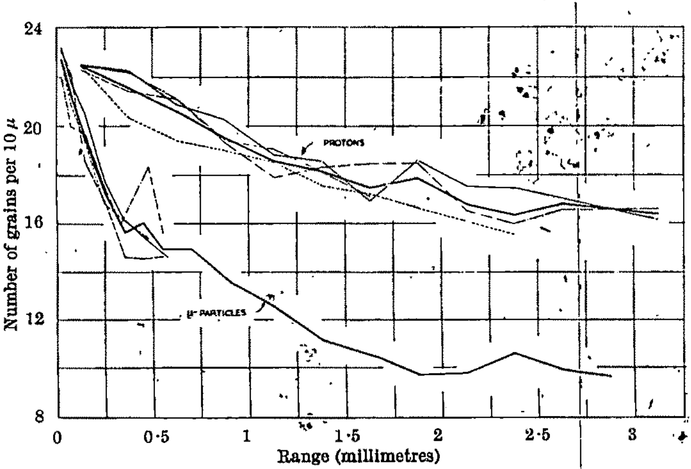

Fig. 9

work only with tracks formed contemporaneously; to compare the grain-density along the tracks of the π- and μ-mesons of the same pair. As a result, the tracks of the π-mesons available for measurement were, in most cases, shorter than 400 μ. In continuing the experiments, much more favourable conditions were obtained by using short exposures, so that the effects of fading were negligible; and by developing the plates by the method employed by Dilworth, Occhialini and Payne[7], which gives a nearly uniform degree of development with depth.

In the plates obtained by these methods, it is legitimate to compare the grain-density in the tracks of unrelated particles. Further, it is now known that at least the majority, and possibly all, the mesons which produce 'stars' are π^--particles[6,8]; and that most of the ρ-mesons are μ^+- and μ^--particles. In determining m_π and m_μ, we have therefore made measurements on the tracks of π^+- and π^--, μ^+- and μ^--particles, of length greater than 1,000 μ, comparing the results with those of similar measurements made on the tracks of protons. In these conditions, we have found $m_\pi/m_\mu = 1{\cdot}33 \pm 0{\cdot}05$. A detailed account of the observations will be published elsewhere; but, for the purpose of the present paper, it is sufficient to note that the results appear to be in good accord with those obtained by other methods. We conclude that, using the Ilford C2 emulsion in the new conditions, reliable information can be obtained.

We have seen that the conditions of uniform development and absence of fading have been achieved in the present experiments with the new Kodak emulsions, and we therefore attempted to measure the mass of particles by similar methods to those employed with the Ilford plates. The results obtained in observations on the tracks of four protons and four μ-particles, occurring in the same plate, are represented in Fig. 9. In this figure, the number of grains per unit length in the tracks is plotted for different values of the residual range; and the mean values, for tracks of the same type, are indicated by the full lines. The ratio of the masses of the two types of particles can be deduced by making a comparison of the values of the residual range at which the grain densities have the same value. The result thus obtained is $m_\mu = 220 \pm 20\ m_e$.

Using similar methods, we have made estimates of the mass of the particle, k, and the measurements are represented in Fig. 10. This figure shows the mean values of the grain-density in the tracks of the four μ-mesons and four protons, together with the corresponding results for the particle k. All the tracks under consideration occurred in the same plate.

Table 1 shows the values of the mass of the particle, k, as determined from these results, by making a comparison of the grain-density in the track of the particle with the mean curve for protons. The values thus obtained are all independent and the mean is $m_k = 1{,}080 \pm 160\ m_e$.

TABLE 1. Determination of the ratio, m_p/m_k, of the mass of a proton to that of particle, k, by grain-counting

	Individual independent values						
m_p/m_k	1·77	1·88	1·49	1·64	2·17	1·79	1·32
	1·71	1·66	1·27	1·69	2·13	1·55	

Mean value: 1·70; $m_k = 1{,}080 \pm 160\ m_e$

The limits of error given above have been deduced in the following manner: We have compared the grain-density in the tracks of the four individual protons with the mean curve for the same particles—(see Fig. 9)—and have thus obtained a number of independent values for the apparent mass of each of these particles. The distribution in these values allows us to calculate the 'probable error' associated with the mass as determined from the observations on any one track, expressed as a percentage of the apparent mass of the particle. It is then assumed that the 'probable' percentage error in the calculated mass of the particle k has the same value.

We have also determined the mass m_k by studying the small-angle scattering of the particle, by the methods recently described[4], and the result thus obtained is $m_k = 1{,}800 \pm 400\ m_e$. If the true mass of the particle is 1,080 m_e, the chance that the value obtained by observations on scattering shall be equal to, or greater than, 1,800 m_e is one in four. Because of the large statistical fluctuations associated with

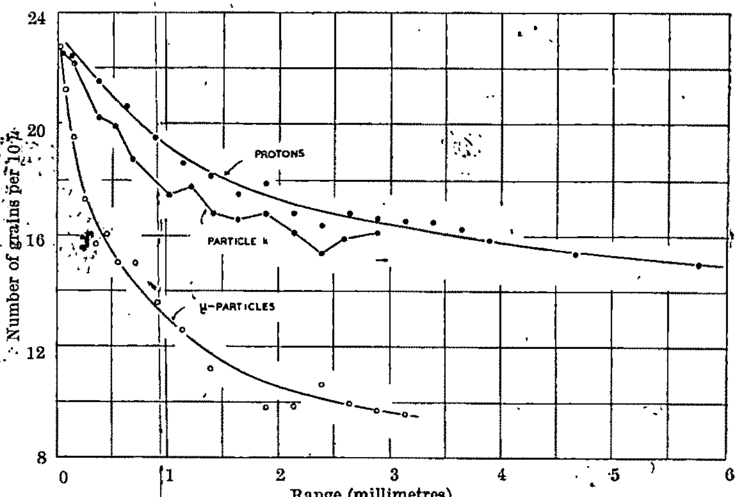

Fig. 10

the observations in the scattering experiments, we give more weight to the measurements by grain-counting. It appears certain, from these observations, that the true value of m_k lies between 700 and 1,800 m_e, and we think it highly probable that it is substantially less than that of the proton. Thus every individual point representing the grain-density in the track k, at a particular value of the residual range, lies below the corresponding points for each of the four protons.

Disintegration 'B'

The tracks, c and d, of the two particles emitted from point B are characteristic of protons or heavier particles, and we regard them as due to a disintegration produced by the particle t. This particle was frequently scattered in passing through the emulsion and was therefore of low velocity; and the evidence is consistent with the assumption that it had reached the end of its range at the point B.

The only known slow charged particle which is capable of producing a disintegration of the type represented by star B is a π^--particle[6,8]. We therefore assume that a negative meson of mass 286 m_e was created at the point A, and reached the end of its range to produce the disintegration B.

Transmutation 'A'

In order to interpret the transmutation A, we first made a detailed examination of the tracks of the emitted particles. Of the two tracks a and b, the former has a length in the emulsion of more than 2,000 μ, and ends in the surface, whereas b ends in the glass and is 116 μ long. The grain-densities in the two tracks are equal to within the limits defined by the statistical fluctuations. The average grain-density in the long track a is 49·0 grains per 100 μ; that is, 2·17 times the value characteristic of minimum ionization for a particle of charge e. Unless we admit the existence of fractional values of the electronic charge, we must conclude that the particles producing the tracks a and b both carried charges of magnitude e.

In order to determine the possible values for the energy of the particles producing tracks a and b, we have calculated the variation with energy of the specific ionization of a particle of charge e, from the formula of Halpern and Hall[9], assuming the atomic composition of the emulsion to be identical with that of the Ilford C2 plates. This formula is a modification of that of Bloch[10]; it applies to particles moving in a solid medium and gives results in good agreement with experiment for particles of low energy. The results are shown in Fig. 11, where the specific ionization is plotted as a function of the quantity E/m, where E is the energy and m the mass of the particle, both quantities being measured in MeV. From Fig. 11, we have determined the possible values of the energy of the particles, a, b, corresponding to the observed grain-density in the tracks, assuming them to be protons, π-mesons, μ-mesons or electrons. The resulting values are tabulated in Table 2.

TABLE 2. Values of the energy and momentum of the particle producing track a, as deduced from the observed grain-density and scattering, making various assumptions concerning the mass of the particle

Assumed particle		proton	π-meson	μ-meson	electron
Energy in MeV.	(a) below minimum ionization	235±95	37±13	27±11	0·13±0·05
	(b) above minimum ionization				> 1,000
Momentum MeV./c	(a) below minimum ionization	700±160	109±22	80±15	0·4±0·1
	(b) above minimum ionization				> 1,000
	(c) from scattering observations	245±40	113±18	100±16	68±11
	(d) from momentum balance	98±5	98±5	98±5	98±5

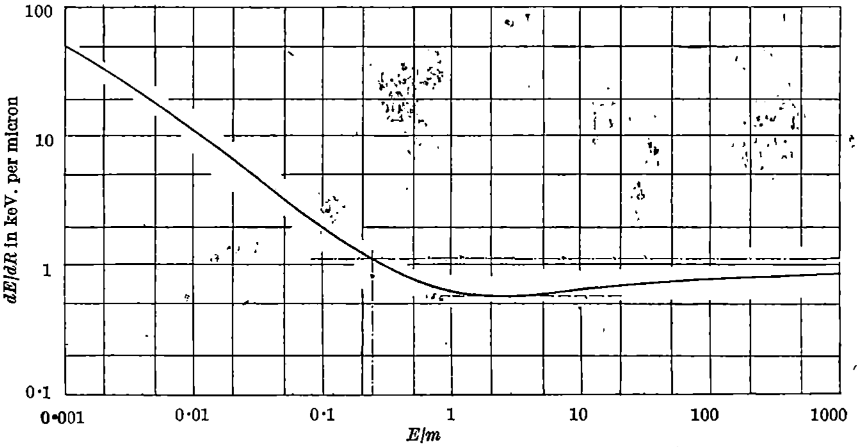

Fig. 11. Variation of the rate of loss of energy of a particle of charge |e| as a function of the quantity E/m, where E is the kinetic energy and m the mass of the particle, both quantities being measured in MeV.

There are two possible interpretations of the transmutation produced at A by the particle k. We can assume, either that the particle was captured by a nucleus, or that it decayed spontaneously. From the measured values of the mass of the particle, it would be possible, from the point of view of the conservation of mass and energy, to admit that, at the end of its range in the emulsion, it was captured by a nucleus and led to the ejection of two energetic protons and a π^--particle. It appears almost certain, however, that the release in a nucleus of such a large amount of energy would lead to the 'evaporation' of many nucleons, a process commonly observed in plates exposed to the cosmic radiation; and that two protons of great energy would be only two components of a 'many-pronged' star. (It may be noticed that we cannot assume that the particle k was captured by one of the rare nuclei of heavy hydrogen, present in the gelatine. In such an interaction, the algebraic sum of the charges on the two initial particles is 0 or $2e$, whereas that of the product particles is e or $3e$.) We shall see later that there are other objections to the hypothesis that the tracks a and b were produced by protons, or heavier nuclei of charge e.

It follows from the above considerations that if we are to describe the transmutation in terms of particles of which the existence is already established, we must attribute the tracks a and b either to electrons, to μ-mesons or to π-mesons. Considering the first of these possibilities, we must assume the electrons to have had an energy value greater than that corresponding to minimum ionization, namely, greater than 1,000 MeV.; for with the alternative lower value corresponding to the observed ionization, 300 keV., the particle would have had a range in the emulsion of only about 100 μ, and would have been frequently scattered. The assumption that the particles *a* and *b* were electrons is therefore inconsistent with the conservation of energy and can be rejected. We are left with the alternatives that the tracks were produced either by π- or by μ-mesons.

If the particles *a* and *b* were mesons, we must assume, in order to conserve mass-energy, that their kinetic energies were 27 MeV. or 37 MeV., respectively, in the case of μ- or π-mesons (see Fig. 11). In either case, it appears to be very difficult to reconcile the observations with the assumption that the particles were emitted as a consequence of the liberation in a nucleus of the energy corresponding to the rest-mass of particle *k*. We are therefore led to examine the possibility of explaining the observations in terms of a spontaneous decay of this particle.

Assumption of a Spontaneous Decay of the *k*-Particle

In examining the possibility that the transmutation *A* corresponds to a spontaneous decay of the particle *k*, we require to know the relative directions of motion of the three ejected particles. For this purpose it is necessary to determine the shrinkage of the emulsion; the ratio, *S*, of the thickness of the emulsion during exposure to that after it had been developed, fixed and dried. We have measured this quantity by examining the tracks of α-particles, produced in the emulsion by uncontrolled radioactive contamination. Among such 'stars', it is possible to identify some, due to an original atom of radiothorium, from which an α-particle of thorium C′ was emitted. The shrinkage has been measured by determining the lengths of the projection of the corresponding tracks on the surface of the emulsion, and their apparent angles of 'dip'. The value of the 'shrinkage' thus found is $S = 2\cdot7 \pm 0\cdot1$. Knowing the value of *S*, the original orientation of a track in the emulsion, before processing, can be determined, in favourable cases, with a precision of the order of 1°, by observing the apparent angle of 'dip' of the particle, and the direction of its projection on the plane defined by the surface of the emulsion. Using these methods, the original directions of motion of the three particles *a*, *b* and *t* were found to be coplanar. The departure of the direction of motion of any one particle from the plane defined by the other two is less than 4°. The error in this determination is largely due to the fact that track *t* is of short range, and the particle producing it was of low velocity, and frequently scattered.

The values of the angles between the directions of motion of the particles in the common plane are shown in Fig. 12. The observed coplanarity makes it legitimate to assume that the three particles arise as a result of the spontaneous decay of the *k*-particle at the end of its range in the emulsion, and that they are the only product of its disintegration; that no neutral particles, which would escape observation, are emitted. It follows that the vector sum of the momenta of the three particles must be assumed to be equal to zero.

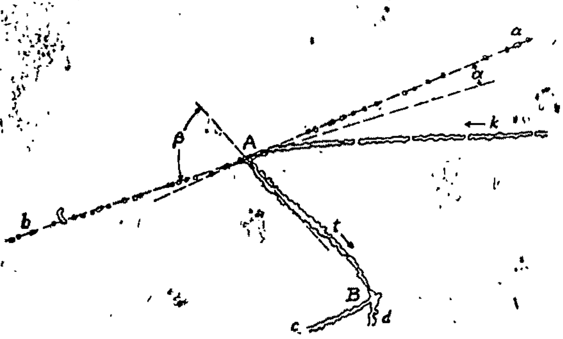

Fig. 12. Facsimile drawing of the event shown in Fig. 8, made with the projection microscope. The actual angles α and β, measured in the common plane of the three tracks, *a*, *b* and *t*, are: $\angle\alpha = 9\cdot8°$; $\angle\beta = 76\cdot6°$

If we are correct in attributing the track *t* to a π^--particle, it follows from the observed range, 45 μ, that the kinetic energy of ejection was 1·04 MeV. The corresponding value of the momentum of the particle is 17·5 MeV./*c*. From the observed directions of motion, the momenta of the particles giving tracks *a* and *b* are then found to be 98 ± 5 and 104 ± 5 MeV./*c*, respectively. These values are to be compared with those corresponding to electrons or mesons listed in Table 2, which have been deduced from the observed grain-density in the tracks. We have seen that the values given in Table 2 for the momenta of the two particles, if they are assumed to be electrons, are many times too large. It follows that there is a wide departure from a momentum balance if the tracks *a* and *b* are assumed to be due to either electrons or protons. Further, the values of the momenta, as deduced from observations on the scattering of the particles, are inconsistent with those obtained from grain-counts, if the particles are assumed to have been either electrons or protons (see Table 2).

The agreement between the sets of values for mesons, however, is most remarkable, and gives strong support for the assumption of a spontaneous decay of the *k*-particle. Only a very rare combination of unrelated features, including the coplanarity of the tracks and the directions of motion of the particles in the common plane, the range of the particle *t*, and the specific ionization of the particles producing tracks *a* and *b*, could produce such an agreement between the estimated values of the momenta, if the result is fortuitous.

The values of the momenta of the particles producing tracks *a* and *b*, as determined by the three different methods, are consistent, within the errors of measurements, with the assumption of a spontaneous decay of the *k*-particle whether the product particles are assumed to be μ-mesons or π-mesons. We can apply a further test by calculating the values of the rest-mass of the particle *k* which corresponds to the two different assumptions, and the results are tabulated in Table 3.

TABLE 3. Estimates of the mass of particle *k* based on total release of mass and energy, for two assumed modes of decay

(i) $k \rightarrow \pi^- + \pi + \pi$

	Track '*a*'	Track '*b*'	Track '*t*'
Particle	π	π	π^-
Rest-mass (m_e)	286	286	286
Energy in m_e	61	64	2

Total = m_k = 985 m_e

(ii) $k \rightarrow \pi^- + \mu + \mu$

	Track '*a*'	Track '*b*'	Track '*t*'
Particle	μ	μ	π^-
Rest-mass (m_e)	212	212	286
Energy in m_e	76	81	2

Total = m_k = 869 m_e

In calculating the energy of the particles producing tracks *a* and *b*, it is assumed that the particle producing track *t* is a π^--particle, of momentum 17·5 MeV./*c*; knowing the relative directions of motion of the three ejected particles, the momenta of the other two particles are determined, and hence the energies corresponding to any assumed mass.

It will be seen from Table 3 that the assumption of two µ-mesons corresponds to a rest mass of the k-particle of 869 m_e; and for two π-mesons, 985 m_e. The assumption of different particles, one π- and one µ-meson, gives an intermediate value of approximately 925 m_e. In view of the error in the direct determination of m_k, the results are not decisive.

If the transmutation is to be interpreted in terms of particles of which the existence is already established, we are left with four possibilities for the nature of the particles producing tracks *a* and *b*. These are indicated schematically in Table 4.

TABLE 4. Comparison of the observed and calculated values of the grain-density in track *b*, for various assumptions regarding the nature of the particles producing the tracks *a* and *b*

	Length of track in microns	Number of grains	Grain-density	Assumed particles 1	2	3	4
Track *a*	2100	1025	49 ± 1·5	π	μ	π	μ
Track *b*	116	59	51 ± 6	π	μ	μ	π
Calculated grain-density in *b*				45	45	34	64

Values of the grain-density are given in grains per 100 µ.

For the following reasons, case 3, Table 4, is the most improbable. If track *a* is that of a π-meson, we can calculate the momentum and the grain-density to be expected in track *b*. We thus obtain the value of 34 grains per micron instead of 51·0 ± 6·0 as observed. For case 4, on the other hand, if *a* is a µ-meson, the calculated grain-density for track *b* is 64, a value which differs from that observed by an amount only twice that corresponding to the standard deviations. The observed grain-densities agree best with the assumption that the two particles are of the same type.

Observations on the scattering of the particle producing track *a* are in better accord with the assumption that it is a π-meson rather than a µ-meson (see Table 2); but the results are again indecisive. We may sum up this evidence, and that provided by the mass determinations by grain-counting, by saying that there is some support for the view that the three product-particles are π-mesons; but that the alternative possibilities of one π- and two µ-, or two π- and one µ-meson cannot be excluded.

Chance Juxtaposition of Unrelated Events

In the light of the analysis made in the preceding sections, we can now return to the original assumption that the event is not to be regarded as a fortuitous juxtaposition of tracks. The accuracy of the determination of the mass of the particle *k* does not allow us to exclude the possibility that it has a mass as great as that of a proton, although the observations by grain-counts render it very improbable. Suppose then that a proton, unrelated to the particles producing the other tracks, came to the end of its range at *A*. Even with this assumption, the event is still difficult to explain in conventional terms. Many examples of π^--particles ejected from stars have been observed in this Laboratory[6], but in the present instance the existence of a nuclear interaction in which two protons of great energy are emitted, unaccompanied by slow protons and α-particles, would remain to be explained. A similar difficulty is met if we assume that a particle producing one of the tracks, *a* or *b*, approached *A* and produced the transmutation.

If, alternatively, the tracks *c* and *d*, diverging from star *B*, represent an unrelated disintegration—produced, for example, by a γ-ray—we could then assume track *t* to be that of a proton. We are then left with the difficulties associated with the features peculiar to star *A*, which must now be assumed to have been produced by a slow, charged particle; difficulties which have already been discussed in a previous paragraph. These considerations give further support to the original assumption, that all the tracks shown in the mosaic represent a succession of associated processes.

Relation of the Present Results to Other Observations

If a particle with the elementary electronic charge suffers a spontaneous decay, the law of the conservation of charge demands that the number of emitted particles of charge *e* shall be odd. From this point of view, the sign of the charge of the original particle can have been either positive or negative. If the particles producing tracks *a* and *b* form a pair of opposite sign, then the original k-particle was negative. The only other alternative is that they were both positively charged, in which case the k-particle was also positive. It is therefore possible that our observations correspond to a mode of decay of positive particles of mass approximately 900 m_e, and that the observation by Leprince-Ringuet[2] demonstrates the fate of the corresponding negative particles—nuclear capture with the production of a 'star' and the ejection of a π^--particle.

Rochester and Butler[2] have published an expansion-chamber photograph which appears to be due to the spontaneous decay of a neutral particle of mass approximately 900 m_e into a pair of oppositely charged particles of rest-mass approximately 300 m_e. We have therefore considered the possibility that the decay process suggested by the present results can be regarded as taking place in two stages: the emission of a π^--particle of low energy, followed by the spontaneous decay of the resulting neutral particle. On this view, however, it would be necessary to assume that the neutral particle has a life-time of the order of 10^{-14} sec. Otherwise, in recoiling from the π-particle, it would move away from the original point of decay, and the two charged particles into which it became transformed would originate from a point separated from the beginning of the track of the π^--particle. It follows that we cannot identify such a postulated unstable neutral particle with that for which evidence is provided in the experiments of Rochester and Butler.

Finally, we have considered the possible relations of the present results to the particles of mass approximately 800 m_e referred to as τ-mesons, evidence for which has been recently reported by Bradt and Peters[2]. It is a remarkable feature of their experiments that their τ-mesons give rise to no recorded secondary particles at the end of their range. It appears to be possible that these particles also decay with the emission of three fast mesons, but that the transmutation usually takes place with a more equal partition of kinetic energy than in the case we have observed. It would then follow that in the Ilford *C2* emulsion the disintegration products would commonly escape observation. If this view is correct, we must regard the event we have observed as representing a rare example of a common mode of decay of these mesons; an example which, by chance, has allowed a detailed analysis to be carried out. If so, the τ-meson of Bradt and Peters, when recorded by electron-sensitive emulsions, should show the tracks of three particles, of low specific ionization, and of which the directions of motion are co-planar.

We have pleasure in thanking Prof. von Muralt and members of the staff of the Jungfraujoch Forschungsstation for hospitality and assistance in obtaining the exposures; Dr. E. R. Davies and Dr. W. E. Berriman, of Messrs. Kodak, Ltd., for special photographic plates; Miss C. Dilworth and Dr. G. P. S. Occhialini for advice on development; Mr. W. O. Lock and Mr. J. H. Davies for assistance in making observations on the scattering of particles in the emulsion; and to the team of microscope observers of this Laboratory. We are indebted to Prof. N. F. Mott and other colleagues for a number of discussions on the processes associated with the capture of negative mesons by nuclei.

Note added in proof. Since completing this article, we have been informed by Dr. Peters that, in Ilford *C*2 emulsions exposed at 90,000 feet, he and Dr. Bradt have observed three events with the following characteristics. A particle, which they judge to be similar in mass to their τ-mesons, appears to come to rest and to lead to the emission of a particle of smaller mass, which, at the end of its range, produces a nuclear disintegration. The ranges of the secondary particles, in the three cases, are 20, 25 and 45 μ, respectively. The authors were not aware of our results when they suggested to us that their observations may correspond to the spontaneous decay of heavy mesons. According to their description, these events are precisely similar to those we should expect to observe in *C*2 emulsions as a result of the spontaneous decay of heavy particles of the type we have postulated; for any particles of low specific ionization will not be recorded by the Ilford plates. The observations of Peters and Bradt appear, therefore, to give further support for the assumption that the present observations are not due to a chance juxtaposition of tracks; and they suggest that it will be possible, in the near future, to find similar examples suitable for making a detailed analysis.

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[2] Leprince-Ringuet, *C.R.*, **226**, 1897 (1948). Rochester and Butler, *Nature*, **160**, 855 (1947). Bradt and Peters, Report to the Bristol Symposium, 1948 (in the press). Alichanian, Alichanov and Weissenberg, *J. Exp. and Theoret. Phys., U.S.S.R.*, **18**, 301 (1948); and other references.

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[10] Livingston and Bethe, *Rev. Mod. Phys.*, **9**, 263 (1937).

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DEVELOPMENT OF LEATHER CHEMISTRY

THE first applications of scientific knowledge to the problems of leather manufacture may be said to have been made about 1890, and the initiation in the following year at the Yorkshire College (now University of Leeds) of a course of lectures devoted to the subject was an indication that a new field of technology had gained recognition. Five years later, through the foresight and generosity of local tanners and the Worshipful Company of Skinners, a special department was built to house the new subject, and H. R. Procter was appointed to fill the newly created chair in 1898.

The industry, which was being encouraged to examine its methods along scientific lines, was one dating from primitive times, and little advance had been made in methods of manufacture or in the principles underlying them since their inception. Moreover, and perhaps because of this, the industry as a whole was a conservative one, and early workers in the field had to contend with a rooted distrust of new ideas which took a long time to break down. It was without doubt fortunate for the future development of the subject that the man chosen to hold a key position at the outset was Procter, who deservedly earned the title of 'father of leather chemistry'. Working in a more leisurely age than the present, he did not publish his well-known theory of protein swelling until 1916; but during the intervening years he was laying the foundations firmly by his influence on the succession of students who passed through his hands, as well as by his own published work. Largely by reason of his efforts, the industry was of a sufficiently scientific turn of mind by 1920 to support the foundation of the British Leather Manufacturers Research Association, which is one of the oldest associations of its kind in Great Britain. The growth of knowledge in this field, and the amount of work which has been done, may be appreciated by a perusal of three publications issued to commemorate the twenty-fifth anniversary of this Association*, which is, in effect, a summary of almost all important investigations relating to leather carried out during the period throughout the world.

Since the materials used in leather manufacture are of many different types, both organic and inorganic, and as the processes employed involve to some extent the application of almost all branches of chemical knowledge, there can be few other industries in which the research worker must be familiar with so many different aspects of chemistry. Many problems have been elucidated by virtue of investigations in other subjects, probably the most fruitful contributions coming from biochemists, especially those working on proteins, as a result of which the composition and structure of the tanner's most important raw material, collagen, is more or less settled. From the realm of organic chemistry have come numerous studies on the constitution of the tannins which, from Fischer's early synthesis of penta-*m*-digalloyl-β-glucose and from Freudenberg's work on the condensed tannins to the work of present day, have materially contributed to the understanding of vegetable tanning. Information on these matters is, however, by no means complete, and recent research, especially on the important tannin constituent of mimosa bark, has directed the attention of leather chemists in particular to the importance of this line of investigation.

In this branch of their subject, as in many others, leather chemists have in many cases made notable contributions not only to the understanding of their own problems but also to chemical knowledge in general. It may not be widely known that Procter's work on the swelling of gelatine was promoted by the observation of swelling phenomena in hides during operations prior to tanning; and the discovery that chromium salts were valuable tanning agents led to a large amount of research on the properties of their solutions, with results of wide interest.

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* Progress in Leather Science, 1920–1945. Vols. 1, 2, 3. Pp. xvi+705. (London: British Leather Manufacturers Research Association, 1946–48.)

Much of the fundamental work on tannery processes has been concerned with the mechanism of tannin–collagen combination, although tanning itself is only one of a large number of operations involved in the manufacture of leather. Several general lines of attack on the problem have yielded valuable information, no matter which type of tanning agent, organic or mineral, has been under examination. The introduction in 1934 of the shrinkage temperature as a measure of the thermal stability of collagen has been used not only as an indication of the increase in cross-bonding between adjacent polypeptide chains which occurs in some types of tanning but also as a means of clarifying protein structure; and some of the latest published work of Jordan Lloyd, who was director of the British Leather Manufacturers Research Association from 1927 until her death in 1946, was concerned with the shrinkage temperature of collagen in organic solvents. Modifications of the reactive groups in collagen by de-amination to remove the lysine amino group, removal of the guanidine group of arginine by Sakaguchi's method, combination with formaldehyde, and methylation, have all been carried out; and the effect has been considered on such properties as combination with acids, bases and tanning agents. Similarly, the influence of modification by tanning on the acid- and base-combining capacity of collagen, and the effect of combination with one type of tanning agent on its behaviour to another contrasted type, have been widely studied. The role of hydrogen ion concentration in manufacture is now well understood, and has been interpreted in conformity with the zwitterion theory of protein structure.

The vegetable tanning process presents a number of questions which have not been answered; and several theories on the mode of combination of tannin and collagen have been proposed, ranging from an adsorption mechanism to salt formation involving the amino groups of the protein molecule. The concept of hydrogen bonds has been invoked to explain not only tannin–collagen combination, but also the relatively large amount of tannin fixed in leather; and it is thought that tannin is bound to tannin by means of hydrogen bonds, and that only about half the tannin shown by analysis to be 'fixed' is actually attached to the protein. In fact, all types of chemical bonds play a part in the process to an extent depending on the constitution of the tannins present, external conditions in the tan liquors, such as *p*H and other factors; and it would be impossible to distinguish the extent of each in any given sample of leather. More important from the tanner's point of view is the fact that much knowledge has been gained about the functions of the non-tannin constituents of the liquors with which he makes sole leather, especially the large number of acids and salts present, which have a profound effect on the quality of the leather produced. In this case, the problem has largely been one of analytical procedure and has been partly solved by the use of ion-exchange resins, combined with the examination of the titration curves of the liquors; but recently the method has been subjected to some criticism.

The chrome-tanning process has proved no less intractable than that using vegetable tannins. It was not until some insight had been gained into the chemistry of chromium salts that any successful attempt could be made to enunciate a theory which would explain the phenomena accompanying chrome-leather manufacture, although the conditions necessary for successful tannage were known long before the reasons for them, especially the importance of the acidity of the bath. The application of Werner's co-ordination theory has proved of enormous value in explaining the course of the reaction, and most theories assume the co-ordination of the chromium complex with some part of the collagen molecule. The increase in *p*H necessary to obtain combination between collagen and the chromium compound affects both the complex itself and the protein, and co-ordination could occur between an ionized carboxyl group and the complex. It seems very likely that combination takes place between adjacent polypeptide chains through the complexes, and this is one explanation of the high degree of stability of chrome-tanned leather towards boiling water. Attempts to explain chrome-tannage on the basis of salt formation have not been so successful, except in cases where anionic complexes are present in the tanning bath.

What might be referred to as less important methods of tanning have not received as much attention, except in the case of formaldehyde, which is linked to the wider problem of the protein–formaldehyde reaction. Quinone tannage, although of no commercial importance at present, has nevertheless been investigated for the light it throws on the vegetable-tanning process.

Many operations other than tanning have been investigated by leather chemists; but space allows mention of only a few. The liming process for the removal of hair, especially the function of unhairing agents in accelerating the reaction, has been explained in the light of a great deal of work carried out on wool, while the effect of the same operation on collagen has been shown to involve mainly the amide groups and possibly the arginine. The most important modification which collagen undergoes in liming is in the alteration of the fibre structure due to plumping, and in the separation of the fibre bundles into fibrils.

Some of the most valuable work carried out, particularly by the British Leather Manufacturers Research Association, has been in the development of microscopic examination as a guide to the quality of leather, and the large number of photographs in the publications referred to bears testimony to the extent to which this method has been adopted. In the field of physical testing, methods have been introduced for the determination of permeability of leather to water and water vapour, resistance to abrasion and allied phenomena, all of which, with certain reservations, give a more immediate and practical indication of quality in use than the older method of chemical analysis. A great deal of less spectacular work has enabled tanners to overcome faults derogatory to the value of their products, such as stains resulting from bacterial action in the curing of the raw hides, various exudations known under the term 'spues', liability of some leathers to rot in acid atmospheres and many other similar defects. These operational problems have been the cause of a large amount of work in Great Britain and the United States for a number of years; but it is true to say that the resistance of vegetable-tanned leathers to acid deterioration especially has been markedly increased.

It has been possible in a short space to indicate briefly no more than a few of the advances made during the last quarter of a century. The chief contributions to the problems involved have been made by chemists in Great Britain, on the continent of Europe, and in the United States, where an Association of Leather Chemists was formed in the early years of this century. Many papers have been published from laboratories of industrial organisations and private firms, which alone shows how far the industry has moved since Procter's early days. In the last decade or so, schools of tanning with attendant research organisations have grown up in South Africa, Australia and New Zealand. While the field has been expanding rapidly, no leather chemist can claim that more than a fraction of the problems which face him has been settled, and it becomes more apparent yearly that most of the operations with which he deals are far more complicated than had been realized. In regard to fundamental problems, the past twenty-five years have seen a notable clearing of the ground. In the realm of manufacture, it is probable that in the future much more attention will be paid to the use of synthetic agents for many tannery processes as replacements for time-honoured natural materials, which for one reason or another are becoming less easily available each year. P. Danby

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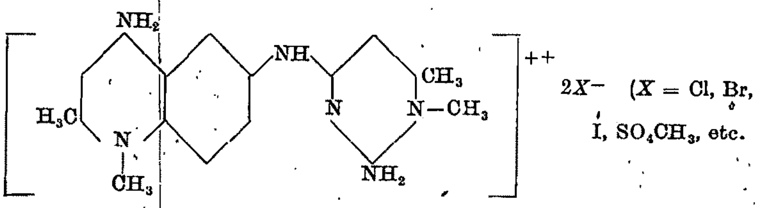
'ANTRYCIDE': A NEW TRYPANOCIDAL DRUG

By (the late) Dr. F. H. S. CURD and Dr. D. G. DAVEY

Imperial Chemical Industries, Ltd., Research Laboratories, Manchester, 9

THE discovery of a new drug, 'Antrycide'*, showing great promise in comprehensive field trials as a trypanocide, has already been referred to in an announcement from the Colonial Office. This new drug resulted from a systematic study of the chemotherapy of trypanosomiasis in these Laboratories, and although a full account of our researches must await later publication, a few preliminary observations may be of interest.

After considerable chemical exploration, 4-amino-6-(2′-amino-6′-methylpyrimidyl-4′-amino) quinaldine-1 : 1′-dimetho salts were found to possess outstanding trypanocidal properties against laboratory infections.



These salts, which have the accompanying formula, will be referred to for convenience as 'Antrycide' salts.

We give in Table 1 a brief summary of the experimental findings obtained with one of these salts in the treatment of various trypanosome infections in mice; in all experiments the drug was administered subcutaneously.

Against a *Trypanosoma congolense* infection, a single dose of 1 mgm. of 'Antrycide' chloride per kilo body-weight was curative. Half this dose effected a proportion of cures. Similarly, activity was shown by this compound against many other experimental trypanosome infections, for example, against those due to *T. rhodesiense*, *T. brucei*, *T. evansi* (India), *T. evansi* (Sudan), *T. equiperdum* and *T. equinum*. Susceptibility to the drug of the different trypanosome species was not uniform throughout the series, but by adjustment of the dose, cures could be obtained in every case. We did not encounter marked toxic effects even with doses many times those necessary for cure.

It should be noted that the figures in Table 1 relate to particular strains of the trypanosome species indicated. Some variation was experienced with certain other strains; for example, one strain of *T. congolense*, isolated in Kenya, showed marked resistance compared with the Busimbi strain, and a dose of about 2·5 mgm./kgm. was required to produce consistent cures in mice.

'Antrycide' salts also possess marked prophylactic action against experimental trypanosome infections. Mice, rats and rabbits were first treated with the drug, and then after a varying period of time were 'challenged' with trypanosomes. It was found that, with suitable doses, the animals could be protected against infection for some weeks. The results of some typical experiments with *T. congolense* (Busimbi strain) in mice are recorded in Table 2. If no trypanosomes were to be found in the blood 28 days after challenging, then the animals were regarded as completely protected (*P* in Table 2). Incomplete protection (*I*) was judged by delayed death as compared with untreated control animals or by the appearance of trypanosomes in the blood of the test animal before completion of the experiment.

Table 1. Trypanocidal action of 'Antrycide' chloride against various *Trypanosoma* species

Dose (mgm./kgm.)	*T. rhodesiense* (Tinde)	*T. brucei* (Liverpool)	*T. congolense* (Busimbi)	*T. evansi* (India)	*T. evansi* (Sudan)	*T. equiperdum*	*T. equinum*
25	*C*						
12·5	*C*						
5	*C*	*C* and *R*					
2·5		*R*		*C*	*C* and *R*		*C*
1·25			*C*	*C*	*C* and *R*	*C*	*C*
1·0			*C*				
0·5			*C* and *R*	*C* and *R*	*R*	*C*	*C* and *R*
0·25			*R*			*C* and *R*	
0·125			*R* and *DD*				

C = Cure: blood freed from trypanosomes for 28 days. *R* = Relapse: blood freed from trypanosomes temporarily, appearing again within 28 days. *DD* = Delayed death: blood not freed from trypanosomes

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* Trade mark of Imperial Chemical (Pharmaceuticals), Ltd.

Table 2. Prophylactic experiments in mice infected with *T. congolense* (Busimbi) using 'Antrycide' chloride

Dose (mgm./kgm.)	Interval between dosing and challenging (days)	Result
25	14	10/10 *P*
12·5	14	8/8 *P*
5	14	4/11 *P*. 7/11 *I*
25	28	8/8 *P*
12·5	28	8/8 *P*
5	28	8/8 *I*
12·5	42	2/6 *P*. 4/6 *I*
5	42	8/8 *I*

Our laboratory results appeared to us to justify field trials, and in association with the Tsetse Fly and Trypanosomiasis Committee of the Colonial Office, and with the Sudan Government, veterinary trials were commenced in Africa. Although these trials are still incomplete, the evidence already available shows that 'Antrycide' salts may be administered subcutaneously with ease and safety and, in single doses, have cured infections of *T. congolense*, *T. vivax* and *T. brucei* in cattle, *T. brucei* in horses, donkeys and dogs and *T. evansi* in camels. 'Antrycide' salts have also been shown by us to give considerable protection to cattle against subsequent infection with *T. congolense* and *T. vivax*. Experiments are still in progress to determine the duration and the character of this prophylactic action, and to ascertain whether the drugs can be used successfully for the protection of cattle maintained in or transported through tsetse areas of tropical Africa. The good correlation obtained so far between laboratory and field results encourages us to expect prophylactic effects of importance.

OBITUARIES

Dr. F. H. S. Curd

The tragic death on December 2 of Francis Henry Swinden Curd, following injuries received a few days earlier in a railway accident, robs chemotherapeutic research of one of its foremost workers, and at an age when his qualities were approaching full fruition.

Born in 1909, he received his early education at Bancrofts School, Woodford. Passing to East London College (Queen Mary College), he graduated in the honours school of chemistry in 1930. There began his association with Dr. (now Prof.) Alexander Robertson, with whom he remained when the latter was appointed to the London School of Hygiene and Tropical Medicine. Until 1933 he collaborated in researches on the synthesis of compounds related to the lichen acids, for which he gained his Ph.D. Although this work did not bear directly on the chemotherapy of tropical diseases, there is little doubt that his interest in this subject was first aroused during the years spent at the London School.

In 1933 he entered the research laboratories of Imperial Chemical Industries, Ltd., at Blackley, Manchester, and like many earlier workers in the field of chemotherapy, served his apprenticeship on an investigation of the chemistry of dyestuffs. Some part of his time, however, was given to a continuation, with Mr. S. Ellingworth, of the studies on the styrylquinoline series of trypanocidal drugs which the latter worker had earlier begun with Prof. J. B. Cohen. In 1936, he was seconded to the newly formed Medicinal Chemicals Section, and for the next three years devoted his full attention to trypanosomiasis.

The shadow of approaching war caused this work to be interrupted, and Curd began the task of devising routes to the German synthetic antimalarial drugs, 'Atebrin' ('Mepacrine') and 'Plasmochin' ('Pamaquin'). Despite the lack of published information on preparative methods, these problems were solved during 1939, and his work laid the foundation for a large-scale manufacture, particularly of 'Mepacrine', at that phase of the War when the drug was most urgently needed.

Experience with this substance indicated its shortcomings and, as in other parts of the world, stimulated the search for more effective agents. Curd was again entrusted with this task, and he began by making an exhaustive study of the existing extensive literature on the chemotherapy of malaria (*Ann. Trop. Med. and Parasit.*, 1943) which stands as a model of what such a survey should be. His attention was early directed to the pyrimidine nucleus as the basis for new synthesis, and with his colleagues he rapidly developed entirely new chemotherapeutic types which culminated in the preparation, in 1944, of the diguanide 'Paludrine'. For his part in this work he was awarded in 1947, jointly with D. G. Davey and F. L. Rose, the Gold Medal for Chemotherapy of the Worshipful Society of Apothecaries.

More recently, Curd's attention had turned again to the problem of trypanosomiasis; and although he died before seeing the completion of his new work, there is little doubt that the outcome of his later researches, when fully revealed in the results of field-trials now in progress in Africa, will mark him as an outstanding figure in chemotherapeutic research, and will emphasize the national significance of his loss. [A preliminary account, with Dr. D. G. Davey, appears on p. 89.—Editors.]

Curd's personal attributes were known to a wide circle of friends in industry, universities and research institutions. A natural gentleman, at all times charming and modest, he was characterized by meticulous care in all he did, and by an enthusiasm which inspired everyone with whom he came in contact. He leaves a widow and three young daughters.

F. L. Rose

By the death of F. H. S. Curd the science of chemotherapy has lost an outstanding contributor. In the years he devoted to the chemotherapy of the parasitic diseases, Curd and his co-workers achieved results the scientific and practical importance of which have not been surpassed in this field. That the investigations in which he was engaged proceeded with smoothness and certainty was largely due to Curd's personal qualities. His sound common sense, well-developed critical faculties, and an unassuming wealth of knowledge allied to remarkable technical ability ensured the hearty co-operation of his associates, chemical, biological and medical, and promoted the directional stability of the investigations in which he played so prominent a part. His place will indeed be difficult to fill.

A. R. D. Adams

We regret to announce the following deaths:

Mr. J. H. Coste, chemist-in-chief of the London County Council during 1913–36, on January 3, aged seventy-seven.

Mr. T. Petch, formerly Government mycologist, Ceylon, later director of the Ceylon Tea Research Institute, on December 24, aged seventy-eight.

NEWS and VIEWS

Physical Chemistry at Manchester: Prof. M. G. Evans, F.R.S.

PROF. M. G. EVANS goes from Leeds to Manchester this month to succeed his former teacher and collaborator, Prof. M. Polanyi, in the chair of physical chemistry. In 1939 he was appointed to the chair of physical chemistry in the University of Leeds, made vacant by the death of Prof. H. M. Dawson, and in 1945, when Prof. R. W. Whytlaw-Gray retired and the Departments of Inorganic and Physical Chemistry were fused, he became the senior professor in the combined department (see *Nature*, **156**, 386; 1945). Immediately on appointment to Leeds, Prof. Evans found himself confronted with all the problems of adapting the work of an important teaching and research school to war-time conditions; but not content merely to keep an efficient department going, he laid the foundations for the great developments which have since taken place. His infectious enthusiasm for his subject has been as effective in teaching as in research, and the inspiring originality which he brought to bear on the organisation and conduct of the teaching of inorganic and physical chemistry in Leeds will long continue to exert its influence there.

Prof. Evans' researches in many fields of physical chemistry were recognized by his election to the Royal Society in 1946. While in Leeds he has contributed largely to the knowledge of the reactions of free radicals in aqueous solution, with special reference to polymerization reactions. His work has been characterized by a particularly happy combination of experiment and theory, and his theoretical work on the energetics and kinetics of free radical and polymerization reactions has been especially noteworthy. He has also made important contributions to the study of oxidation-reduction reactions and of diffusion problems. During the War Prof. Evans played a leading part in planning and carrying out investigations on chemical defence problems. His activities ranged over a wide field, and whether in committee work, in theoretical discussions or in practical breathing tests in toxic clouds, he did not spare himself. During the past nine years, Prof. Evans has given unstinting service to the University of Leeds as a whole. His transference to Manchester will be felt not only in the Council, Senate and lesser bodies at Leeds, but also by many of his colleagues who have been accustomed to rely on his wisdom, good judgment and human sympathy for help in a variety of matters often very remote from chemistry.

Mining at Birmingham: Prof. S. G. Ward

PROF. STACEY G. WARD has accepted the invitation of the Council of the University of Birmingham to the chair of mining and to become director of the Mining Department; he is relinquishing the chair of chemical engineering which he has held since 1946. Prof. Ward obtained his fundamental scientific and engineering education in the Imperial College of Science and Technology, London, and carried out research in pure chemistry before transferring to research on coal. He has been intimately connected with the mining industry since 1930, when he joined the Powell Duffryn Company. For three years prior to appointment in 1937 to the staff of the Mining Department at the University of Birmingham, he was field research and liaison officer to the British Iron and Steel Federation. He was acting professor of mining from 1943 until the appointment of Prof. T. David Jones in 1947, and, at the request of the Faculty of Science, became acting head of the Department after Prof. Jones' death in that year.

It is intended to expand the Department of Mining at Birmingham, which includes coal mining, coal preparation and treatment, metalliferous mining and mineral dressing, not only on the teaching side but also, and particularly, in connexion with research. Special attention will be paid to teaching fundamental subjects and principles involved in mining, and it is hoped to reserve time in the course for liberal studies. The research work will be expanded, in the first place, on that now in progress on fundamental problems of ventilation, drilling, mine lighting, mineral dressing, coal constitution, spontaneous combustion and coal cleaning (on which Prof. Ward has had a team working for some time). Special post-graduate courses for those who have had industrial experience will be introduced. The reorganised Department will eventually be accommodated in new buildings and laboratories which have already been planned but for which building permits cannot yet be obtained.

Physiology at Liverpool: Prof. R. A. Gregory

DR. R. A. GREGORY, who has recently been appointed to the Holt chair of physiology in the University of Liverpool, is an honours graduate in physiology of the University of London (University College). While at University College he held the Bayliss–Starling Memorial and Sharpey Scholarships, and received College and University awards. His work up to that time had been on biochemical problems of carbohydrate metabolism, the circulation, with particular reference to the metabolism of the heart, and the resistance of the body to hot environments. In 1939 he was awarded a Rockefeller Foundation Fellowship, spending most of his time in A. C. Ivy's laboratory in Chicago, where he became interested in problems of the gastro-intestinal tract. On his return to Great Britain, the surgical technique he had acquired enabled him to make valuable contributions to one of the war-time research projects fostered by the Ministry of Supply. After the War, during which he held the post of lecturer at University College, he was appointed senior lecturer in the University of Liverpool and resumed his work on the fundamental physiology of digestion. In addition to numerous papers in physiological journals, he has contributed chapters to Wright's "Veterinary Anæsthesia" and Winton and Bayliss' "Human Physiology". Prof. Gregory succeeds Prof. W. H. Newton, who has been appointed to the chair of physiology at Edinburgh.

Wellcome Chemical Research Laboratories: Dr. S. Smith

DR. SYDNEY SMITH, who recently retired from his appointment as director of the Wellcome Chemical Research Laboratories, will retain a connexion with the Wellcome Foundation, Ltd., as consultant. Dr. Smith joined the staff of the Wellcome Chemical Works at Dartford in 1914 and served for many years as head of the experimental laboratories. He initiated and developed many important technical processes, and in pure research became well known for his discovery of digoxin. He became works manager in 1936, and in the following year was appointed a director of the Wellcome Foundation, Ltd. In 1941 he left the works in order to establish the new Wellcome Chemical Research Laboratories at Beckenham. Here, after setting up temporary laboratories, he was responsible for the planning and development of the extensive permanent laboratories opened in 1946.

A Giant Meteorite

IN the issue of *L'Astronomie* for October 1948 there is an account of an enormous meteorite which, on February 12, 1947, fell in the Sihot-Alin chain of mountains, in the vicinity of the Amoor River, Eastern Siberia. M. Krynov, secretary of the Commission of Meteorites of the Academy of Sciences of the U.S.S.R., who took part in the expedition which investigated the nature of the phenomenon, states that this meteorite is probably one of the largest that has ever struck the earth, and M. Fessenkov, who presides at the work conducted on meteorites, believes that the object was a minor planet. The fall was observed by the inhabitants of towns and villages over a radius of 200 kilometres around the place of impact, and those who were questioned agree that the body was moving from north to south, that its time of flight was between four and five seconds, and that it was more brilliant than the sun which was then shining on a beautiful morning in a clear sky. The noise of the fall and of a series of explosions which accompanied the flight of the object could be heard at distances of 200 km. Preliminary estimates of its mass give this as about a thousand tons.

It has been estimated that the speed of the meteorite was about 20 kilometres a second and that its surface temperature, acquired by friction with the atmosphere, was of the order of 5,000° C. It broke up into thousands of fragments of various sizes, and these lost their speed by friction with the atmosphere, falling on the earth merely by its gravitational attraction. Pieces were found over an area represented by a circle of 12 km. radius. In an oval sector of 0·75 sq. km. the members of the expedition found more than a hundred funnels in the rocks, caused by the fall of the debris, the diameters of these funnels varying from 0·5 to 28 m., and some of them attained a depth of 6 m. All around were found trees overthrown or damaged, and a number of large cedars were found split in two. On examining very carefully the neighbourhood of the fall, the expedition of 1947 discovered 257 fragments of the meteorite, varying in weight between 0·16 gm. and 1·8 tons, and about 5 tons of cosmic iron were collected, while the next expedition in 1948 collected about 4 tons more. Aerial photographs of the region were taken during 1948, and about 48 sq. km. have been declared a closed district and placed at the disposal of the Academy of Sciences of the U.S.S.R. for five years.

Jurassic Holostei

THE questions of the classification of the fishes and of the interrelationships of the different groups are occupying the attention of modern zoologists. In such a study, which involves fossil forms, a consideration of the bones of the skull and their homologies must play an important part. The dermal bones, among other skeletal structures, are often quite well preserved and so have received much attention. On the other hand, the neurocrania, being partly obscured by the dermal bones and only capable of study in particularly well-preserved specimens, are nothing like so well known although quite important. Hence the interest of a study of the neurocrania of some Jurassic Holostei recently made by Dr. Dorothy H. Rayner (*Phil. Trans. Roy. Soc.*, B, **601**; 1948). A special technique involving the grinding of the specimen and the taking of a series of transfers 0·1 mm. apart was elaborated from a previous method suggested by E. C. Case in 1937. An appendix describes the technique fairly fully, and it will probably be of use in other lines of work involving the sectioning and reconstruction of fossil material. In spite of considerable variation in the neurocranial ossifications, which differ among closely related forms and apparently in the same species with difference of age, there is, save in the supraoccipital and post-otic regions, sufficient similarity to allow of broad homologies being drawn. This and other evidence adduced suggests that the Jurassic Holostei may be regarded as a natural group. Two particular points may be noted. There is sufficient similarity between the neurocrania of the Jurassic *Lepidotus* and the living *Lepidosteus* to suggest relationship between them, and in *Caturus* and *Dapedius* there is a lateral cranial canal without external opening to which, at present, no function can be assigned.

Mental Health and World Citizenship

THE World Federation for Mental Health has published as a booklet a statement produced by the International Preparatory Commission for the International Congress of Mental Health which met in London in August 1948. Although the statement will appear in the published Proceedings of the Congress, the expressed wish that it should be given a wide circulation has resulted in its production in the present form. The International Preparatory Commission sat for a fortnight prior to the Congress and was made up of twenty-four persons from ten different countries representing the points of view of sociology, psychology, psychiatry, social work, anthropology, political science, philosophy and theology. As the raw material for its deliberations, reports were available from three hundred preparatory commissions composed of about five thousand workers in the different fields who had been working during the preceding year in twenty-seven countries. The booklet is obtainable from H. K. Lewis and Co., Ltd., 136 Gower Street, London, W.C.1.

Family Health Service in South Africa

THE current issue of *Biology and Human Affairs* (14, No. 2; Autumn 1948) contains an article on the Family Health Service in South Africa, where twenty health centres have been established in various parts of the country by the Ministry of Health. A description is given of the Polela Health Centre which was set up in 1940 in a rural native reserve in south-western Natal. The family health service was first applied to a small area within the reserve and was gradually extended until, within four years, almost six thousand people were included in the scheme. This has led to a marked improvement in the health indices in that part of Polela where the family health service is in operation, and other health services have now been planned for the reserve, so extending the facilities to the entire population of the area. The article contains a detailed account of the way in which the service has been organised.

Humanitas

THE autumn number of *Humanitas*, just issued, completes the second year of publication of this quarterly journal. Throughout its eight issues, *Humanitas* has maintained an admirably high standard. It is edited by a joint board of university students and teachers, under the chairmanship of Prof. M. Polanyi. Its contributors include Bertrand Russell, D. M. MacKinnon, C. V. Wedgwood, Sherwood Taylor, C. F. von Weizsäcker, Storm Jameson and Dorothy Emmet. In its scope it embraces the philosophy of science and history, and questions of religion and education. Its purpose is to awaken interest in the moral and social responsibilities of scholarship. The autumn number is notable because it contains a full text of the recent broadcast between Bertrand Russell and Father Copleston. *Humanitas* may be obtained from Dr. W. Schenk, University College, Exeter.

Colonial Service : Recent Appointments

THE following appointments in the Colonial Service have been announced: H. A. Fooks, temporary assistant conservator of forests, Nigeria; T. Geddie, agricultural superintendent, Nigeria; T. O. Ellis (agricultural chemist, Jamaica), senior agricultural chemist, Jamaica; J. C. Eyre (senior agricultural officer, Palestine), deputy director of agriculture, Northern Rhodesia; B. G. Owen (senior agricultural officer, Nigeria), assistant director of agriculture (produce inspection), Nigeria; R. M. Harley (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; R. G. Hiller (senior assistant conservator of forests, Northern Rhodesia), senior assistant conservator of forests, Uganda; A. C. Russell (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; C. J. Taylor (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; N. F. Bowers (development officer, Nigeria), field officer, West African trypanosomiasis research, Nigeria. The following have been appointed assistant conservators of forests in the countries mentioned: A. E. Beveridge (Federation of Malaya), W. Carmichael (Tanganyika), D. G. Cumming (Northern Rhodesia), J. Grant (Sarawak).

British Social Hygiene Council : Summer Schools

THE British Social Hygiene Council is arranging two summer schools this year, one in England, the other in Switzerland. The first will be held at 'Elfinsward', Haywards Heath, Sussex, during August 1–14, and the second at the University of Berne, during August 17–September 1.

The course at 'Elfinsward', which will be entitled "The Teaching of Biology", is intended primarily, though not exclusively, for teachers in secondary modern schools and of junior forms in grammar schools. The director of the School will be Mr. W. L. Sumner, of the University of Nottingham. The fee, including registration, is £15 15s. In the Swiss Summer School, which will have as its theme "The Family and the Nation", an attempt is being made to cater for the needs of social workers who are interested in the family. It should appeal especially to children's officers, probation officers, magistrates, health visitors, almoners, nurses and teachers, though members of the general public will be equally welcome. The cost, including travel, hotel accommodation and tuition, will be approximately £34. Further information can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Summer School in Micro-Chemical Techniques

A COURSE in micro-chemical techniques will be held at the Queen's University, Belfast, during June 20–July 2, for the third successive year. Instruction will be given in centigram and milligram techniques which are of general use in various branches of inorganic and physical chemistry. Operations such as micro-electrolysis, chromatography and chemical microscopy, which are of increasing importance in diverse fields, are optional. In addition, exercises in microgram analysis will be available for specialists.

Announcements

PROF. LINUS PAULING, professor of chemistry at the California Institute of Technology, Pasadena, and M. Henri Besaire have been elected *correspondants* for the Section of Mineralogy of the Paris Academy of Sciences, in succession to the late J. C. de Lapparent and M. Leriche.

SIR NOEL ASHBRIDGE, director of technical services of the B.B.C., and Mr. H. Bishop, chief engineer of the B.B.C., will deliver the Faraday Lecture of the Institution of Electrical Engineers on February 16, at 6.30 p.m. They will speak on "Television", and will give demonstrations and experiments. The lecture will be delivered at the Central Hall, Westminster, London, and admission will be by ticket, obtainable on application to the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. The Lecture is also to be delivered at various towns throughout the country.

THE University of London has arranged a course of three lectures on "The Application of Atomic Piles in Nuclear Physics", to be delivered by Sir John Cockcroft. The lectures will be given at the Senate House, on February 2, 9 and 16, 1949, at 5.30 p.m. Admission is free and without ticket.

Two full-day conferences on "Combined Heat and Power Supplies" have been arranged by the Institute of Fuel and will be held at the Institution of Mechanical Engineers on January 25 and April 27. The conferences will be open to the public, but admission is by ticket only, to be obtained from the Secretary, Institute of Fuel, 18 Devonshire Street, London, W.1.

MARCONI INSTRUMENTS, LTD., are showing a wide range of industrial measuring instruments at their London showroom, 109 Eaton Square, S.W.1, during March 14–25, and all interested in electronics and process control are invited to apply for admission tickets either to Marconi Instruments, Ltd., St. Albans, Herts, or the London showroom.

The Cecil Peace Prize of £100 is open to all members (less than twenty-five years old) of the universities of the United Kingdom. The subject for the year 1949 is: "What international action should be taken with regard to the many millions of displaced or expelled persons and refugees in Western Europe, with a view to both the restoration of European economy and to the utilization of labour power now running to waste". Essays must be sent before November 1 to the Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1.

THE Operational Research Club (see *Nature*, October 23, p. 646) announces a change of address. The address of the honorary secretary, Mr. D. Neville-Jones, is now 14 Sheen Gate Gardens, East Sheen, London, S.W.14.

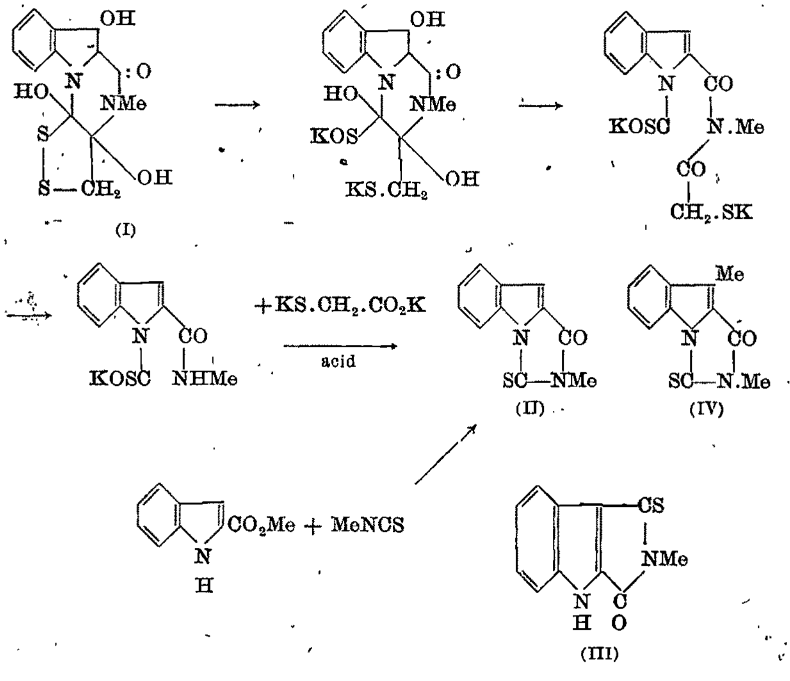
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Synthesis of a Sulphur-containing Degradation Product from Gliotoxin

GLIOTOXIN, a potent fungicide isolated from culture filtrates of *Gliocladium fimbriatum*, *Trichoderma viride* and other organisms[1], has been extensively examined by J. R. Johnson and his colleagues[2], who ascribe to it the provisional structure (I). The presence of the pyrazinoindole nucleus and of the disulphide grouping appear to be established with reasonable certainty. The points of attachment of the disulphide grouping to the pyrazinoindole nucleus, on the other hand, merit further confirmation. Treatment of gliotoxin with methanolic potassium hydroxide followed by acidification of the reaction mixture gives a sulphur-containing product, m.p. 188°, which appears to have the molecular formula $C_{11}H_8ON_2S$ and for which the thiohydantoin structure (II) has been suggested[3].

Interaction of methyl indole-2-carboxylate and methyl *iso*thiocyanate gives a product, $C_{11}H_8ON_2S$, m.p. 189°, which is identical with the compound obtained from gliotoxin. In view of the reactivity of the 3-position in the indole ring system, it is possible to formulate the reaction product, $C_{11}H_8ON_2S$, from methyl indole-2-carboxylate and methyl *iso*thiocyanate as either (II) or (III). The latter structure has been excluded since we find that methyl 3-methylindole-2-carboxylate reacts with methyl *iso*thiocyanate to yield the thiohydantoin (IV), the ultra-violet absorption spectrum of which is virtually identical with that of the synthetic compound, m.p. 189°. Furthermore, methyl 1-methylindole-2-carboxylate failed to react with methyl *iso*thiocyanate. We conclude that the degradation product from gliotoxin is 2-thio-1-methylindolo-1′ : 2′-3 : 4-hydantoin (II).



The identification of this degradation product affords support for the view that one point of attachment of the disulphide grouping in gliotoxin is *via* a carbon atom directly linked to the indole nitrogen. The mechanism of formation of the thiohydantoin from gliotoxin, involving a contraction of a six- to a five-membered ring, may be represented by the accompanying scheme; this has the merit that it requires the observed alkali consumption, and is in accord with the fact that the thiohydantoin is not a primary product of the degradation of gliotoxin with alkali but that it is produced following the acidification of the reaction mixture.

J. A. ELVIDGE
F. S. SPRING

Royal Technical College,
Glasgow. July 27.

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[1] Weindling and Emerson, *Phytopath.*, **26**, 1068 (1936). Weindling, *ibid.*, **24**, 1153 (1934); **31**, 991 (1941). Brian, *Nature*, **154**, 667 (1944). Brian and Hemming, *Ann. App. Biol.*, **32**, 214 (1945). Waksman and Geiger, *J. Bact.*, **47**, 391 (1944). Menzel, Wintersteiner and Hoogerheide, *J. Biol. Chem.*, **152**, 419 (1944). Glister and Williams, *Nature*, **153**, 651 (1944). Brian, *Trans. Brit. Mycol. Soc.*, **29**, 211 (1946). Stanley, *Aust. J. Sci.*, **6**, 151 (1944). Stanley and Mills, *Aust. J. Exp. Biol. and Med. Sci.*, **24**, 133 (1946).

[2] *J. Amer. Chem. Soc.*, **65**, 2005 (1943); **66**, 614, 617, 619 (1944); **67**, 423, 1736 (1945); **69**, 2364 (1947).

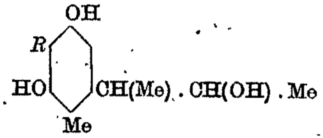
[3] Dutcher, Johnson and Bruce, *J. Amer. Chem. Soc.*, **67**, 1736 (1945).

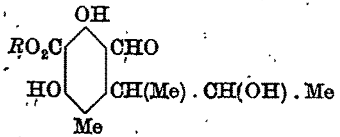
A Synthesis of Citrinin

FOLLOWING upon the development of a new structural formula for citrinin described in a communication[1] submitted to *Nature* on March 17, 1948, we have now been able to effect a synthesis of citrinin, thereby confirming our earlier deductions.

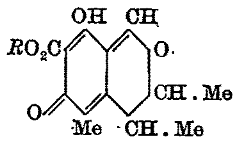
By means of a carboxylation process with potassium hydrogen carbonate and glycerol at 150°, phenol '*A*' (i, $R = H$) was converted into the carboxylic acid (i, $R = CO_2H$), m.p. 185° (decomp.). From its method of formation[2] and its ferric reaction, it is clear that the latter compound is a γ-resorcylic acid and not the isomeric β-resorcylic acid, a conclusion confirmed by the ultimate success of our synthesis. The application of the Gattermann reaction to the acid (i, $R = CO_2H$) or its methyl ester (i, $R = CO_2Me$) gave rise to formyl derivatives (ii, $R = H$) and (ii, $R = Me$) which, on treatment with concentrated sulphuric acid at room temperature for a short time, were converted, without racemization, respectively into citrinin (iii, $R = H$), m.p. 175° (decomp.), $[\alpha]_D^{18^\circ}$ − 37·4° (*c.* 1·15 gm. in ethanol) and its methyl ester (iii, $R = Me$), m.p. 139° (decomp.). The synthetical compounds were identical in every way with the natural substances and, further, the synthetical ester exhibited all the characteristic properties of the natural derivative. Similarly, starting with phenol '*B*', the optically inactive isomeride of '*A*', we have also synthesized an optically inactive citrinin, m.p. 175° (decomp.).

In connexion with the synthetical formation of citrinin from phenol '*A*' it may be noted that a synthesis of the dimethyl ether of '*A*' has already been achieved by way of the optically inactive di-





II



III

methyl ether of phenol '*B*', and also that the dimethyl ether of phenol '*A*' has now been demethylated (with accompanying racemization) to give phenol '*B*'. Consequently, the only remaining step required for the complete synthesis of optically active citrinin from *o*-toluic acid is the resolution of phenol '*B*', a project which is at present in progress in these laboratories.

It is now clear that the results of the analytical and synthetical work carried out in these laboratories completely invalidate the structure proposed more recently for citrinin by Gore *et al.*[3], and, further, also establish the misleading nature of the evidence as to constitution which these authors[4] claim from a study of the behaviour of citrinin towards diazonium salts.

N. J. Cartwright
A. Robertson
W. B. Whalley

Department of Organic Chemistry,
University, Liverpool. Oct. 21.

[1] Brown *et al.*, *Nature*, **162**, 72 (1948) (submitted March 17, 1948).

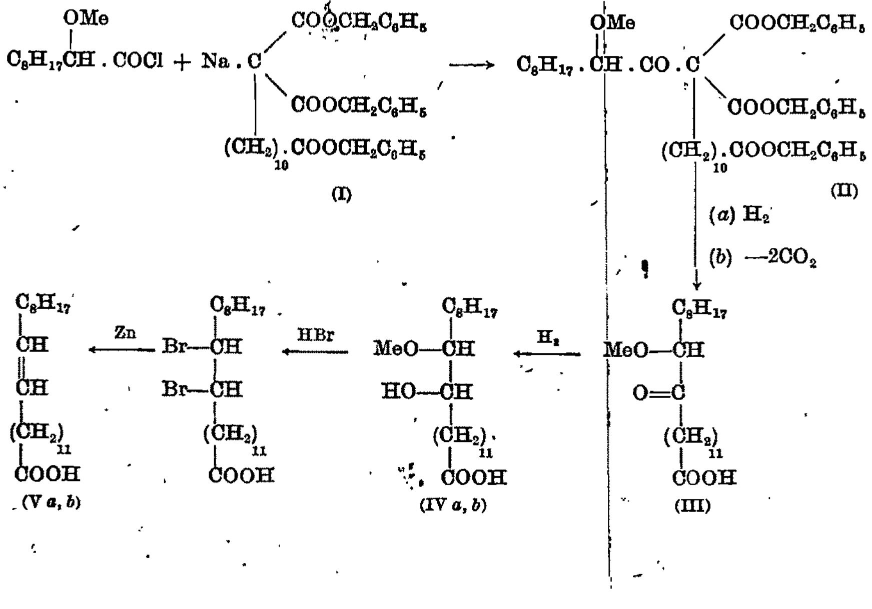
[2] Robertson and Robinson, *J. Chem. Soc.*, 2196 (1927).

[3] Gore *et al.*, *J. Amer. Chem. Soc.*, **70**, 2287 (1948).

[5] Gore *et al.*, *Nature*, **157**, 333 (1946).

Synthesis of Erucic and Brassidic Acids

THE recent publication[1] of a new method for the synthesis of the naturally occurring unsaturated fatty acids, by way of the analogous acetylenic compounds, prompts an early report of similar work carried out in these laboratories employing the following route:



(I) (II) (III) (IV *a, b*) (V *a, b*)

In this manner the total synthesis of erucic and brassidic acids has been achieved.

Sodio tribenzyl undecane-1:1:11-tricarboxylate (I), prepared from the corresponding sodio triethyl ester in benzene solution by treatment with benzyl alcohol (3 mol.) and removal of ethanol azeotropically, yielded on condensation with α-methoxycapryl chloride a product (II) which on hydrogenolysis and decarboxylation[2] gave rise to 13-methoxyheneicosan-12-one-1-carboxylic acid (III).

Pondorf reduction of the latter furnished a solid methoxy-hydroxy-acid (IV*a*) together with a liquid product (IV*b*) thought to be a mixture of the isomers. Treatment of these materials with hydrogen bromide followed by zinc dust yielded brassidic (V*a*) and a mixture of brassidic and erucic acids (V*b*) respectively. Both acids were obtained pure by crystallization, and were found to be identical with those obtained from natural sources (m.p. and mixed m.p., *p*-bromophenacyl esters, equivalent weights and hydroxylation to the requisite dihydroxybehenic acids).

The application of this synthesis to that of other mono-ethenoid acids and more complex members of this group is under investigation and will be reported at a later date.

R. E. Bowman

Department of Chemistry,
Birkbeck College,
London, E.C.4.
Oct. 28.

[1] Ahmad and Strong, *J. Amer. Chem. Soc.*, **70**, 1699 (1948).

[2] Bowman, *Nature*, **162**, 111 (1948).

n-Amylpenicillin

n-AMYLPENICILLIN was first prepared in an impure state by Catch, Cook and Heilbron[1] by the catalytic hydrogenation of Δ^2-pentenylpenicillin, the product being characterized by conversion to the penillic acid and by the identification of *n*-caproic acid among the products of hydrolysis of the latter substance. The presence of *n*-amylpenicillin in the mixture of penicillins formed by the submerged fermentation of *P. chrysogenum Q* 176 has also been reported; but the isolation of the pure penicillin has not yet been recorded. This penicillin has now been isolated in the pure state and characterized.

The separation from the other penicillins was achieved by partition chromatography of the salts of the penicillins with N-ethylhexamethyleneimine, using water adsorbed on silica gel as the stationary phase and wet ethyl acetate as the moving phase.

Microchromatographic assay by the method of Goodall and Levi[2] confirmed that the penicillin was free from contamination by other penicillins. By biological assay, using sodium benzylpenicillin as the standard, the potency of the sodium salt was 1,680 u./mgm. when tested against *S. aureus* (N.C.T.C. 6571) by the turbidimetric method, 1,670 u./mgm. when tested against *S. aureus* (N.R.R.L. 313) by the cylinder plate method, and 660 u./mgm. when tested against a strain of *B. subtilis* by the cylinder plate method. Thus *n*-amylpenicillin has a *B. subtilis* : *S. aureus* assay ratio of 0·39.

Sodium *n*-amylpenicillin crystallizes in the form of flat, blunt-ended needles, with one molecule of water of crystallization from moist acetone or moist ethyl acetate. The anhydrous salt rapidly takes up one molecule of water on exposure to atmospheric moisture, and, on account of this, accurate analysis of the sodium salt was difficult. A sample of sodium *n*-amylpenicillin which had been dried *in vacuo* over phosphorus pentoxide at 100° C. gave: C, 49·5 ; H, 6·3 ; N, 8·7 per cent (calculated for $C_{14}H_{21}O_4N_2SNa$: C, 50·0 ; H, 6·25 ; N, 8·34 per cent). The anhydrous salt had a melting point of 188° C. (decomposition) and $[\alpha]_D^{23}$ 319° ($c = 1$ per cent in water).

Conversion of *n*-amylpenicillin to the isomeric penillic acid gave a product which crystallized from warm methanol as stout rods of melting point 182° C. and $[\alpha]_D^{23}$ 534° (at a concentration of 0·5 per cent in decinormal sodium carbonate). Recrystallization from aqueous methanol gave crystals of a hydrate. The anhydrous acid was not hygroscopic. Found : C, 53·2 ; H, 7·14 ; N, 8·90 per cent ; calc. for $C_{14}H_{22}O_4N_2S$: C, 53·5 ; H, 7·00 ; N, 8·92 per cent. X-ray powder photographs of the penillic acid gave results practically identical with those obtained by Mrs. D. Hodgkin from the sample prepared by Catch, Cook and Heilbron.

The constitution of the penicillin was established by acid hydrolysis and identification of the *n*-caproic acid produced as its *p*-toluidide and *p*-bromphenacyl ester.

T. LEIGH

Imperial Chemical Industries, Ltd.,
Research Laboratories,
Hexagon House,
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Aug. 10.

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[1] Catch, J. R., Cook, A. H., and Heilbron, I. M., Brit. Pat. 584,852.

[2] Goodall, R. R., and Levi, A. A., *Analyst*, 72, 277 (1947).

Variations in Force Constants

IN general, small variations in a given force constant in different molecules cannot be accepted as having any absolute significance. This is obvious when we consider how the value of any particular force constant in a polyatomic molecule is obtained[1]; usually, as many constants as possible are carried over from related molecules, and the whole set adjusted to fit the observed vibration frequencies. The final values will depend on the force field used ; the usual convention is to introduce an interaction term into the potential energy expression whenever any large adjustment becomes necessary which cannot be correlated with the structural features, for example, the presence of bonds of intermediate type, due to resonance.

Related to the general problem is the question of group frequencies ; here we have vibrations largely localized within a particular chemical grouping (or, in some instances, a linkage), which remain comparatively unaffected by changes in the molecular residue. Small variations in a group frequency may be due to changes in the overlapping coupling co-ordinates, and therefore, in general, cannot be employed to measure variations in the main constant for the group vibration.

It is of considerable interest that by applying a general normal co-ordinate treatment to the non-planar group of vibrations of related series of substituted ethylenes, it has been found possible to obtain consistent sets of small variations in the force constants for the non-planar bending motions, and to correlate these variations with the observed shifts in the group frequencies and with the electro-negativities and electron-donating powers of the substituents[2]. From calculations on twelve compounds, a linear relation between the CH_2 bending constant (f_{CH_2}) and the corresponding group frequency (δ_{CH_2}) is obtained, and used to fit a further nine compounds into the series. Substitution by CH_3., CH_3.CO.O., and the halogens leads to a decrease in f_{CH_2} compared with its 'neutral' value in ethylene ; the increment in $CH_2 : CX_2$ is greater than in $CH_2 : CHX$ for all the examples studied, and increases with the electro-negativity of the substituent X, being particularly large for fluorine. Substitution by .CN and .CO.OMe leads to positive increments.

These facts suggest that the main effect operative is analogous to the electromeric (resonance) effect directing aromatic substitution ; the powers of conjugation of vinyl and phenyl are known to be approximately equal. CH_3., CH_3.CO.O. and the halogens lead to *o*- and *p*-substitution, and .CN and .CO.OMe to *m*-substitution. Thus, withdrawal of electrons from the terminal carbon atom of the vinyl group results in an increase in the forces opposing non-planar bending of the $=CH_2$ group. The relatively high value of f_{CH_2} in formaldehyde can then be explained by the fact that this molecule is a resonance hybrid in which the ionic structure $\overset{+}{C}H_2—\overset{-}{O}$ is of considerable importance. The low value of f_{CH_2} in allene suggests that this is also a resonance hybrid, with contributions from ionic structures $\overset{-}{C}H_2—\overset{+}{C}=CH_2$, $CH_2=\overset{+}{C}—\overset{-}{C}H_2$. In the allyl halides the resonance effect is inhibited by the $—CH_2—$ group, and the order of the frequencies δ_{CH_2} is the reverse of that in the vinyl halides. The chloride lies roughly midway between propylene and ethylene, agreeing with the fact that in $\varphi CHCl_2$ there is no appreciable difference in the reactivity at the *o*-, *p*- and *m*-carbon atoms.

The resonance effect cannot operate directly on the odd C—H bond in $CH_2 : CHX$; the bending constant f_{CH} decreases as the electro-negativity of the substituent X increases, .CN now lying between CH_3. and Cl., and the effect again being particularly large for fluorine. The values of f_{CH} in acetylene and benzene (non-planar) suggest that there may be an inverse relation between the constants for C—C stretching and for bending of the adjacent C—H bonds.

A full account of this work, including a detailed treatment of problems arising from the solution of the secular equations, is to be published elsewhere[2].

P. TORKINGTON

39a Palliser Road,
London, W.14.
July 19.

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[1] Herzberg, G., "Infra-Red and Raman Spectra of Polyatomic Molecules" (D. van Nostrand Co., Inc., New York ; London : Macmillan and Co., Ltd., 1945), where further references are given.

[2] Torkington, P., *Proc. Roy. Soc.* (in the press).

Metabolism of Nicotinic Acid by Infants

THE recent work of Knox and Grossman[1] has shown the existence of a new metabolite of nicotinic acid. They produced evidence that N-methylnicotinamide was oxidized by enzymes in the liver of the rabbit to N-methyl-2-pyridone-5-carboxylamide, and isolated that compound from the urine of human subjects who had been given daily doses of 0·6–0·9 gm. nicotinamide.

A method[2] for the estimation of N-methyl-2-pyridone-5-carboxylamide in human urine has recently been worked out and has been applied to urines from adults and new-born children. 24-hour specimens were obtained from the adults, and the total amounts of urine passed by the children in the first 72 hours of life were collected. The results of the analysis of these urines are shown in the accompanying table.

Urinary excretion of N-methylnicotinamide and of N-methyl-2-pyridone-5-carboxylamide by newborn infants and by adults

Urine specimen	Subject No.	Total urinary output (mgm.) N-methyl-nicotin-amide (NM)	Total urinary output (mgm.) N-methyl-2-pyridone-5-carboxylamide (P)	$\frac{P}{NM}$
Infants (total excretion in first 3 days after birth)	1	5·3	1·7	0·3
	2	4·7	1·6	0·3
	3	4·3	1·0	0·2
	4	7·1	2·1	0·3
Mean		5·4	1·6	0·3
Adults (24-hr. specimens)	1	8·9	12·5	1·4
	2	7·3	11·9	1·6
	3	7·4	10·8	1·5
	4	5·5	14·9	2·7
Mean		7·3	12·5	1·8

It is clear that the ratio of the pyridone to N-methylnicotinamide was much lower in the urine of the infants than in the urine of the adults. This suggests that the rate of enzyme activity in the infant was much lower than in the adult, and offers an explanation of the very high urinary excretion of N-methylnicotinamide in the first days of life reported by Hamil, Coryell, Roderuck, Kaucher, Moyer, Harris and Williams[3]. The results of these workers have in this respect been confirmed in the course of the present investigation.

R. F. A. DEAN
W. I. M. HOLMAN

Department of Experimental Medicine,
Cambridge and Wuppertal,
B.A.O.R.

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[1] Knox, W. E., and Grossman, W. I., *J. Biol. Chem.*, 166, 391 (1946); 168, 363 (1947).

[2] Holman, W. I. M. (to be published).

[3] Hamil, B. M., Coryell, M., Roderuck, C., Kaucher, M., Moyer, E. Z., Harris, M. E., and Williams, H. H., *Amer. J. Dis. Children*, 74, 434 (1947).

Bile Pigments from Normal Erythrocytes

Gardikas, Kench and Wilkinson[1] have found that treatment of human erythrocytes with acetic acid in an oxygen-free atmosphere, in the absence of ascorbic acid, did not yield any biliverdin when the ether solution was extracted with 5 per cent hydrochloric acid. They claim that the bile pigments isolated by Lemberg and co-workers[2,3] from human and sheep erythrocytes, and from horse oxyhæmoglobin, may have arisen as an artefact from choleglobin, the latter being formed from oxyhæmoglobin by the action of ascorbic acid; ascorbic acid had been added in these experiments to prevent the oxidation of biliverdin to bilipurpurin. They have overlooked, however, that bile pigments had been obtained in an even somewhat higher yield without the addition of ascorbic acid, and also from horse carboxyhæmoglobin[2]. The yield is also unaltered if ascorbic acid is added together with the acetic acid, instead of being added immediately before acidification.

I have now repeated the experiments with sheep and human erythrocytes in the absence of ascorbic acid and of oxygen, removing oxygen either by evacuation or by carbon monoxide. In both instances the total bile pigment yield was 7–9 μgm. per ml. of human or sheep erythrocytes. Little biliverdin is found under these conditions, the main product being a weak-basic bilipurpurin, which is extracted from ether by 20 per cent hydrochloric acid.

In order to allow other workers to repeat these experiments, the method of isolation is given in detail.

After removal of oxygen by exhaustion or by repeated saturation with carbon monoxide, 10 ml. of erythrocytes are treated with 50 ml. of 80 per cent acetic acid; after standing for 15 min. at room temperature, the solution is diluted with 120 ml. of peroxide-free ether. Up to this point, the whole procedure is carried out in an oxygen-free atmosphere. The precipitated protein is now filtered off, and the ether solution is washed five times with an equal volume of water with cautious shaking. The first three washings are re-extracted with small amounts of ether, which are added to the main bulk of the ether solution. The hæmatin, which at this stage begins to precipitate, is removed by filtration through thin filter paper (Munktell, No. 1*F*), and the filtrate is washed once more with water.

This solution is fractionated as follows. Three extractions with 10 per cent hydrochloric acid (3 ml. each) yield a somewhat cloudy extract, which is cleared by washing three to four times with small volumes of ether with the addition of some glacial acetic acid. This 10 per cent hydrochloric acid extract is faintly green and contains a little biliverdin. The ether solution remaining after these extractions is now extracted three times with 20 per cent hydrochloric acid (5 ml. each). This extract is cleared and freed from emulsified hæmin by washing with ether and acetic acid. It is blue to blue-violet and contains mostly bilipurpurin. Finally, the remaining ether solution is extracted once again in the same manner with the same volume of 20 per cent hydrochloric acid. The cleared extract is faintly yellow and serves as a blank for the bilipurpurin estimation. The solutions are analysed in the spectrophotometer in 6-cm. tubes as described by Lemberg and coworkers (see ref. 2, p. 370, method III). The fact that the second extraction with 20 per cent hydrochloric acid does not yield any bile pigment shows that this is not derived from the hæmin.

These experiments prove that the bile pigments thus isolated are derived from a precursor present in the erythrocytes, not from hæmoglobin.

R. LEMBERG

Institute of Medical Research,
Royal North Shore Hospital,
Sydney.
Aug. 9.

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[1] Gardikas, C., Kench, J. E., and Wilkinson, J. F., *Nature*, 161, 607 (1948).

[2] Lemberg, R., Legge, J. W., and Lockwood, W. H., *Biochem. J.*, 35, 363 (1941).

[3] Lemberg, R., and Legge, J. W., *Austr. J. Exp. Biol. and Med. Sci.*, 20, 65 (1942).

Reduction of Tetrazolium Salts by some Biological Agents

TETRAZOLIUM salts, first prepared by Pechmann and Runge[1], have attracted the interest of workers in biological fields since the demonstration by Kuhn and Jerchel[2] that living organisms such as yeast, garden cress and bacteria have the power of reducing the colourless, soluble tetrazolium salts to red, insoluble formazan compounds, reduction taking place in neutral solution and the cells taking up the colour. Mattson *et al.*[3] confirmed these results and showed that a similar reaction was given by many other viable tissues of both plant and animal origin; they suggested that reduction is due to dehydrogenase systems requiring co-enzymes I or II. Straus *et al.*[4] applied the test to normal and neoplastic human tissues. They argued that, as malignant tumours show an increased glycolytic activity, their reducing power for tetrazolium salts might also be augmented. These authors claim that this hypothesis is confirmed by their initial results.

It would obviously be of importance to possess a simple method of establishing the viability of tissues. The following experiments were made in order to decide whether the reduction of tetrazolium salts is restricted to living tissues. Triphenyl tetrazolium chloride was prepared in this department by Dr. D. H. Marrian by the method of Mattson (personal communication). Preliminary experiments confirmed that a 1 per cent solution was readily reduced by many plant tissues, and by human leucocytes and mouse liver, brain, kidney, striped muscle, cartilage and mammary carcinoma.

Fresh brewers' yeast rapidly reduced the salt, the reaction being completely inhibited by heating to 60° for three periods of ten minutes. The yeast was not inactivated by suspension in acetone or absolute alcohol for two periods of one half-hour and subsequent drying, or by air-drying. Air-dried yeast remained active after seven months, as did acetone-dried mushrooms after four months. A seven-year-old sample of air-dried yeast had lost its reducing power.

Yeast extract (Lebedew) was prepared by air-drying fresh yeast, incubating it at 37° in three volumes of distilled water for two hours, and filtering at 5°. The extract was cell-free, apart from a few bacilli; it rapidly reduced triphenyl tetrazolium chloride and preserved its activity when precipitated with absolute alcohol and ether and dried. It was inactivated by heating to 60° for two periods of ten minutes. Dialysing for 2–24 hours abolished its reducing power, but this could be restored by adding phosphate and glucose, or boiled undialysed extract, or concentrated dialysate; it was lost after dialysing for 70 hours, without being restored by the addition of phosphate, glucose, co-enzyme I, adenosine triphosphate and magnesium ions. The reaction given by fresh yeast extract was not inhibited by *M*/90 iodo-acetate, potassium cyanide or sodium fluoride, but slowed by *M*/60 iodo-acetate. Reduction proceeded in the absence of fermentation and was not accelerated by its presence, as shown in the accompanying table. (Experiments done at 37° in phosphate buffer at *p*H 7·4.)

Although reduction occurred without a concomitant fermentation of glucose, its onset was accelerated when glucose was added to dialysed extract, the effect being independent of glucose concentration within the range 3–150 mgm./per cent. In this reaction, glucose could be replaced by galactose, mannose, raffinose or xylose, but not by dulcite, inosite, salicin or mannitol.

Expt. No.	Nature of sample	Reduction first visible (min.)	Glucose concentration (mgm./per cent)		Fermentation
			Initial	After 30 min.	
1	Yeast extract	2½	202	199	Absent
2	Dried yeast	2	134	163	Absent
3	Fresh yeast	2	243	134	Present

The experiments show that tetrazolium salts can be reduced by non-viable cells and by cell-free extracts, and that reduction in yeast is independent of fermentation.

I am indebted to Dr. E. Friedmann for his advice in the planning of these experiments.

F. W. GUNZ
(Saltwell Research Student,
Royal College of Physicians
of London)
Department of Radiotherapeutics,
University of Cambridge.
Sept. 9.

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[1] Pechmann, H. v., and Runge, P., *Ber. deutsch. chem. Ges.*, **27**, 2920 (1894).

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Plasma Cells in the Reaction against Rabbit Tissue Homografts

THE well-known correlation between the breakdown of homografts and their invasion by lymphocytes[1,2] has acquired new interest because of current views on the role of lymphocytes in the manufacture and transport of antibodies[3]. It has been shown that the breakdown of homografts results from a process of active immunization of the host[4]; and since there has been a failure to demonstrate appreciable antibody in the serum[5], it seemed probable that the lymphocytes were the instruments of destruction. More recently, plasma cells have been put forward as producers of antibody[6,7], and this hypothesis suggested a search for these cells in homografts by employing the Unna–Pappenheim stain (methyl green pyronin). With routine staining methods only a few mature plasma cells were identified among the lymphocytes in the period before graft breakdown.

Grafts of submaxillary gland were implanted intradermally (six per rabbit), and one excised together with its surrounding skin every fourth day thereafter and fixed in mercuric chloride-formalin.

In sections stained with methyl green pyronin, the invading cells were found to include, besides true lymphocytes, a large number of cells staining strongly with the pyronin. The latter were of several varieties: (1) Large cells of reticular aspect corresponding to Fagræus's "transitional cells" as found in the spleen. These have large, lightly stained nuclei with reddish nucleoli and moderately red cytoplasm. They are not numerous. (2) Cells resembling the foregoing type but smaller and occasionally with more chromatin in their nuclei. These correspond to Fagræus's "immature plasma cells"; they are not numerous in most grafts. (3) Cells resembling lymphocytes but with cytoplasm staining red, often with the same intensity as mature plasma cells. They include the small, medium and, less commonly, large lymphocytes (the standard by which the various sizes of lymphocyte were judged was that of Maximow and Bloom's "Textbook of Histology", 4th ed.; the greater amount and density of the chromatin in the lymphocytes were taken to distinguish them from reticular cells). They are more numerous than the reticular type of cell. (4) Cells which are intermediate in appearance between the three foregoing classes and mature plasma cells. These are the most numerous. (5) Forms with two and occasionally more nuclei; they are numerous in some specimens. (6) Mature plasma cells as typified by a low nucleus to cycloplasm ratio, eccentricity of the nucleus, and cytoplasm which stains deeply red and usually has the characteristic 'clear area'.

On the fourth day after implantation, very few invading cells are present in the graft. However, large numbers are present on the eighth day when breakdown of the graft epithelium is about to start and the graft blood vessels are greatly dilated and engorged. Preliminary cell counts give one pyronin-stained cell for every two or three unstained lymphocytes; the latter are nearly all small lymphocytes with cytoplasm either invisible or so faintly stained as to be just seen. Among the pyronin-stained cells mature plasma cells are outnumbered by immature ones. Reticular-type cells are usually few, although in a small minority of specimens they are abundant.

On the twelfth day, when much of the graft epithelium has already been destroyed and vascular breakdown is widespread, there is no significant change in the proportion of pyronin-stained cells relative to unstained lymphocytes. However, among the pyronin-stained cells the proportion of mature plasma cells has increased so that they equal or outnumber the immature forms. By the sixteenth day, when destruction of the graft epithelium is complete, mature plasma cells are in a clear majority. Even fewer cells of the reticular type were found in these later stages than on the eighth day. Grafts placed in an animal which had been sensitized by means of six grafts from the same donor twenty-four days previously were similarly invaded; but the proportion of pyronin-stained cells was higher than in the corresponding grafts of the first set of six, and graft breakdown occurred earlier.

The graft blood vessels contained a few pyronin-stained cells: those resembling lymphocytes (category (3) above) and cells intermediate between them and mature plasma cells; occasionally a reticular-type cell was found. Unstained lymphocytes and monocytes were more numerous. Mature plasma cells were not found inside the vessels, although their perivascular accumulation was a striking feature of the grafts.

Mitotic figures were not uncommon in the pyronin-stained cells, mainly in those which appeared to be of the medium lymphocyte type; they were also found in some which appeared to be the "transitional cells" of the Fagræus classification.

While recognizing the pitfalls in tracing cellular life-histories from transitional stages, nevertheless use of the serial biopsy technique makes it reasonable to infer that development of plasma cells, at least in its later stages, takes place in these homografts; and while consistent with the view that plasma cells develop from reticular cells, these observations seem to lend equal support to the view that they develop from lymphocytes. There is no evidence, however, that lymphocytes which arrive at the graft in a non-pyronin-stainable condition develop into plasma cells: it is conceivable that only those which arrive in a stainable condition, indicative of a modification undergone elsewhere, can so develop.

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Entamœba muris: a Complicating Factor in the Experimental Infection of Rats with *E. histolytica*

The introduction of the young rat as an experimental host for *Entamœba histolytica* in the investigation of amœbicidal substances[1,2] has made the study of natural amœbic infections of rodents of great importance. Adequate descriptions of these do not exist. Fulton and Joyner[3] have recently directed attention to this problem, but their descriptions are incomplete.

I have made a study of the morphology and host-parasite relationships of *E. muris* found in rats and mice which will be published elsewhere. The main details will be summarized here, in order to clarify the position.

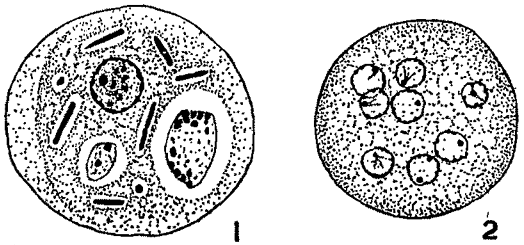
The trophic amœbæ of *E. muris* measure 12–30 μ in diameter, and move by protrusion of pronounced ectoplasmic pseudopodia; food vacuoles contain bacteria, intestinal debris, or other protozoa. When stained, the nucleus is seen as a vesicular structure, with a peripheral layer of chromatin granules, equal in size and distributed evenly over the whole surface, the karyosome being typically eccentric in position.

The amœba encysts in the cæcum and passes out of the host with the fæces. Immature cysts usually contain a large glycogen vacuole. The mature cysts contain eight nuclei and usually measure 13–18 μ in diameter. Chromatoid bodies are not commonly present in the ripe cysts, but when observed were usually bar-shaped with irregular ends. The structure of the cystic nuclei is similar to that of the nucleus of the trophic amœba.

E. muris is morphologically identical to *E. coli* of man. It is distinguished from *E. histolytica* by: (*a*) the eccentric position of the karyosome, (*b*) the cysts containing eight nuclei (see accompanying illustration).

The amœbæ in infected mice were morphologically identical with those in rats, and their cysts were infective to rats. The organism is non-pathogenic, since no lesions were discovered in the alimentary canal of infected animals. An infection of hamsters by a similar species was also shown to be infective to rats[4]. It is likely that infections in other laboratory rodents are closely related to *E. muris*.

It was not possible to cultivate the amœbæ in Dobell and Laidlaw's[5] or other culture media.



E. muris from rat. Fixed in Schaudinn's fluid, stained in iron hæmatoxylin, × 1,500. (1) Trophic amœba. (2) Mature cyst

The effect of emetine hydrochloride and carbarsone was determined upon experimental infections of *E. muris* in rats. The rats, which were of an age similar to those used for routine *E. histolytica* experiments, were infected with *E. muris* by administering orally a suspension of mature cysts, each rat receiving ten to twenty cysts. The drugs were given, mixed in a known percentage with the dry mash diet, at a dose-level known to be therapeutically effective against *E. histolytica*. The rats were fed with the drug diet immediately after infection with *E. muris*, and were killed after six days continuous feeding with this diet.

Effect of emetine hydrochloride and carbarsone upon *E. muris* in the rat

Drug	Drug in the diet (per cent)	Proportion of rats positive for *E. muris*
Emetine hydrochloride	0·008 0·004	2/3 5/6
Carbarsone	0·4	3/5
Controls		8/11

The accompanying table shows that although not all of the rats inoculated became infected, neither of these drugs had any significant action *in vivo* upon *E. muris*. The highest dose of emetine hydrochloride was toxic to the rats. Hegner and Eskridge[6] found that a single dose of 1 gm./kgm. of carbarsone freed rats from infection with trichomonads, but had no effect upon *E. muris*.

It is important in experiments in which rats are used for experimental infections with *E. histolytica* to make sure that the results are not rendered valueless by the presence of *E. muris*. This may be ensured by the selection and care of the animals used. Rats should be aged eighteen to twenty-one days, since at this age they have not commenced to ingest solid food, and are most susceptible to infection with *E. histolytica*. The animals should be bedded upon sterile wood wool, and suitable precautions taken to prevent contamination by other laboratory rodents. The cæca of rats of this age are small, of a pink colour, and contain mucus, but no food particles or protozoa. Microscopic examination showed the presence of desquamated tissue cells, which superficially resembled amœbæ, but were generally smaller, were motionless, and could be distinguished from amœbæ with certainty by examination of stained films. Rats bought in the open market are seldom suitable, as the conditions are difficult to control, and rats of this age are difficult to transport satisfactorily.

Work upon experimental amœbiasis in rats has many pitfalls, and requires a supply of rats which are bred under controlled conditions, together with the collaboration of a protozoologist.

I should like to thank Miss S. I. Pluthero for technical assistance.

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Relationship Between the Average Carcase Weight of Rams, Ewes and Lambs

FROM a statistical analysis of the returns of the twenty-five Ministry of Food collecting centres in West Wales for the four years 1943–46, it has been found that the regression equation of the average lamb carcase weight ($X1$) on the average carcase weights of ewes ($X2$) and rams ($X3$) is:

$$X1 = 3{\cdot}42 + 0{\cdot}511\,X2 + 0{\cdot}125\,X3.$$

These estimated weights of lambs ($X1$) fit closely to the observed weights (estimated dressed carcase weight) according to the χ^2 test.

An equally close fit was obtained from the empirical equation:

$$R + E = \Pi L,$$

while a good fit was given by

$$R + E = 3L,$$

where R, E and L stand for the estimated dressed carcase weight of rams, ewes and lambs respectively.

The above expressions have been obtained from the analyses of the returns for more than half a million lambs, approximately 70,000 ewes and nearly 6,000 rams, and they show remarkable agreement for a wide range of estimated dressed carcase weights, as determined by the graders of the Ministry of Food. Warman[1] has shown that the estimated dressed carcase weights have been very close to the actual carcase weights after slaughter.

In West Wales the ranges in estimated dressed carcase weights at different centres have been as follow: rams, 51·9–91·5 lb.; ewes, 38·1–69·5 lb.; and lambs, 28·3–52·6 lb.

On the assumption that the average weight of the progeny at maturity is equal to that of the mean of the parents, then the above formulæ imply that producers sell their fat lambs when they attain 63·6–66·6 per cent maturity.

There is evidence of a definite stratification of the sheep industry in this region in both time and space, and it would appear that it can be correlated with variations in climatic conditions. The details of this study will shortly be ready for publication elsewhere.

This investigation has formed part of a survey of animal health and production in West Wales, and thanks are due to the scientific branch of Messrs. Cooper, McDougall and Robertson, Berkhamsted, for financial support. Grateful acknowledgment is also made to Mr. Percy George, for the assistance he has given with the statistical analysis.

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Sulphur-containing Amino-Acids in the Rumen Bacteria of Sheep

As part of the investigations proceeding in this laboratory on the physiology and nutrition of sheep, the cyst(e)ine (cystine plus cysteine, calculated as cystine) and methionine contents of two large samples of mixed rumen bacteria were determined. The samples were obtained from slaughterhouse rumens selected to represent sheep from 'dry' and 'green' feed conditions respectively, the absence of green material in the rumen being taken to indicate 'dry'-fed and its presence to indicate 'green'-fed animals.

The whole rumen contents were strained into cans through several thicknesses of gauze, transported to the laboratory and chilled in a refrigerated room. The materials were then strained through cloth and centrifuged first at low speed (21,000 r.p.m.) to remove food particles, protozoa and yeast cells, then at a higher speed (34,500 r.p.m.) to throw down the bacteria. Microscopic examination showed the solid material to be practically free of food particles. The bacterial sludge was spread out in shallow dishes and dried in a hot-air oven at 50–60° C. The resulting dry samples appeared as rather dark translucent flakes and were found to be virtually free from fibre.

Representative 10-gm. samples were taken from these dried preparations and ground to pass through a 0·5-mm. sieve prior to analysis. 'Whole' protein preparations were prepared from the ground samples by the method of Lugg[1], as modified by Lugg and Weller[2]. Nitrogen determinations were made by the micro-Kjeldahl method, cyst(e)ine and methionine determinations by the differential oxidation method of Lugg[3] together with the modified procedure of Lugg and Weller[2] for total sulphur. The results are presented in the accompanying table.

No.	Protein preparations	Per cent of total nitrogen	Per cent of total nitrogen	
			Cyst. N	Meth. N
1	Rumen bacteria from sheep on 'dry' feed	8·78	1·63	1·18
2	Rumen bacteria from sheep on 'green' feed	9·62	1·50	1·54

The cyst(e)ine and methionine nitrogen contents of the preparations are expressed as percentages of the total nitrogen present, each figure being the mean of closely agreeing duplicate determinations. It is apparent that the two samples differ in certain respects. The differences in the nitrogen and cystine contents of the 'whole' protein preparations are not great; but the methionine values are significantly higher for the sheep on 'green' feed than for sheep on 'dry' feed. This difference could be due either to an effect of diet on the nature of the bacterial proteins, independent of the bacterial types, or to differences in the types of organisms comprising the two mixed samples, or to a combination of both. Further evidence on these possible alternatives is being sought. Many workers have shown, however, that changes in the nature of the diet result in qualitative as well as quantitative changes in the rumen floral population[4–7], while others have shown that the amino-acid constitution of bacterial and yeast proteins is fairly constant over a wide range of growth conditions.

Because of the inadequate methods available to early workers, reliable data for the sulphur-containing amino-acid contents of micro-organisms, with which our results may be compared, are meagre. Recently, however, Camien *et al.*[9] have reported the methionine contents of the proteins of four species of Lactobacilli and the cystine content of *L. fermenti*, and Block and Bolling[10] the cystine and methionine contents of eight strains of yeast. Our samples of rumen bacteria differ in several important respects from these. The rumen bacterial protein is, in each case, twice as rich in cystine as the yeast protein and twenty times as rich as the *L. fermenti* protein. It is also considerably richer in methionine than the protein of Lactobacilli, although not greatly different from yeast protein in this respect.

A comparison with the figures obtained from leguminous seeds, for which similar methods of estimation to ours were used[11,12], shows the rumen bacterial protein to be richer in cystine and very much richer in methionine than any of them, including the soya bean, which was the best of those examined. A similar comparison with the figures reported for such 'quality' proteins as casein and muscle protein[13] shows that our rumen bacteria contain protein similar in methionine content to these materials but very much richer in cystine.

It is apparent from these comparisons that rumen bacterial protein is rich in both cystine and methionine. This finding is of considerable importance, in view of its obvious relationship to the theory that in ruminants dietary nitrogen is largely converted to bacterial protein prior to digestion and absorption[14], and to the finding that in these animals the value of non-protein nitrogenous substances, such as urea, is greatly enhanced when supplemented with methionine[15–17].

The nutritional significance of these findings will be discussed more fully in a later publication, in conjunction with other data.

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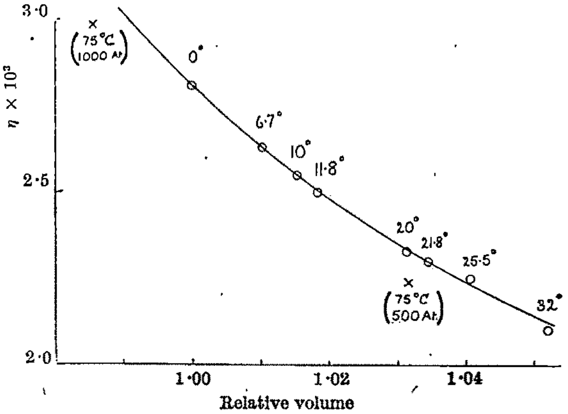
Viscosity–Volume Relation for Liquids

Dr. Jobling, in his letter published in *Nature* of October 16, states that the dependence of the viscosity of a liquid on temperature is "certainly for ether above 0° C. and probably for many other liquids" due entirely to the change of volume. That this is not so in general has often been pointed out by one of the present writers[1]. For example, for mercury (a monatomic liquid and so more suitable than ether to be cited in support of a theory of liquid viscosity) the temperature variation of viscosity at constant pressure in the range 30–75° C. is reduced only by some thirty per cent when the volume, instead of the pressure, is kept constant[2]; for *iso*amyl alcohol, working at constant volume reduces the temperature variation by some twenty-two per cent only: nowhere in the whole range of recorded experiments on carbon dioxide is the viscosity a function of the specific volume alone. Dr. Jobling also states that on Born and Green's theory the part of the viscosity that depends upon molecular attraction is a "volume effect": this, however, is not proved, or even asserted, by the authority quoted by him, and is certainly not asserted or implied by Born and Green[3]. The only experimental results that Dr. Jobling brings forward to support his contention refer to ether above 0° C. However, even for ether in the temperature-range considered, from 0° to 32°, the evidence fails.



The continuous curve shows the variation of viscosity of ether with volume at atmospheric pressure, the temperatures corresponding to the various points being indicated. The two isolated points refer to 75° C. and the pressures indicated

For ether in the region in question there exists, over and above the data for the variation of viscosity with temperature at atmospheric pressure, only one experimental point, that for 75° C., and a pressure of 500 atmospheres. The enlarged portion of Dr. Jobling's diagram, for relative volume $v = 0{\cdot}98$ to $1{\cdot}05$, which we have prepared, shows this point and also that for 75° and 1,000 atmospheres. These two points indicate a viscosity which, at a given v, is well below that at atmospheric pressure and shows no signs of progressive approach. Further, from consideration of the 30° and 75° isothermals for ether due to Bridgman[4], the ratio $\left(\frac{\partial\eta}{\partial T}\right)_v \Big/ \left(\frac{\partial\eta}{\partial T}\right)_p$ which indicates the relative importance of the variation of viscosity with temperature at constant volume and that at constant pressure, and which should be zero according to Dr. Jobling, has been plotted by us against p. This ratio diminishes in an approximately linear manner from 0·56 at 2,000 atmospheres to about 0·1 at atmospheric pressure: the plot indicates that it would not be zero until a pressure of about − 500 atmospheres was reached, and no one has so far been able to put a liquid in the state of tension indicated by this large negative pressure.

The position is, then, that, from the behaviour of one particular liquid in a restricted temperature-range, Dr. Jobling has drawn a certain conclusion about the behaviour of liquids in general—but that the behaviour of the liquid in the range in question does not, in fact, support his hypothesis.

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Green's Theory of Liquid Helium

IN a recent communication[1], H. S. Green remarks that "the application of the Born–Green theory of liquids[2,3] to helium II has been completed and it has been found possible, without further assumption, to explain all the well-known properties of this liquid". A discussion of this theory must be postponed until the detailed calculations of Green are published. Nevertheless, a few remarks may be made on the basis of the preliminary communications[1,3].

The crucial point in any theory of liquid helium is the interpretation of the λ-point. In order to understand Green's ideas on this phenomenon, one must recall that—as is generally agreed—there are two essentially different molecular mechanisms responsible for the viscosity of fluids. Only the first mechanism appears in ideal gases. It consists in the transport of momentum by the thermal agitation of the molecules resulting in a so-called kinetic viscosity. In liquids there is another mechanism completely overshadowing the first. It is due to the fact that the molecules have to pass potential barriers in order to enable one liquid layer to glide over another. Thus the flow near a solid wall occurs by means of an activation process. The corresponding viscosity was called 'potential viscosity' by Born and Green[3] and 'dynamic viscosity' by Tisza[4,5]. Usually the two viscosities can be easily distinguished by their characteristic temperature dependence. The kinetic viscosity has a weak positive, the potential viscosity a strongly negative, temperature coefficient.

According to Green, the transition of helium I to helium II is due to a rapid drop in the potential viscosity. Thus helium I is supposedly a normal liquid, whereas helium II is characterized by a very small viscosity. This interpretation cannot be reconciled with experimental facts.

In the first place, the measurements of Keesom and MacWood[6] clearly show the absence of potential viscosity in both helium I and II (for a discussion of this question see ref. 5; Figs. 1 and 2 especially show the striking contrast between the viscosity of hydrogen, a classical liquid, and helium I, a quantum liquid).

A second point is that the transition from helium I to helium II cannot be described by assuming any particular value—no matter how extreme—for the viscosity of helium II. The change is more radical, and the macroscopic hydrodynamic equations themselves must be changed by going from the ordinary one-fluid hydrodynamics to a two-fluid hydrodynamics[4,5,7].

The idea of the two-fluid hydrodynamics was originally suggested by F. London's[8] well-known interpretation of the λ-point as a Bose–Einstein condensation[4]. Recently, however, it has been developed on essentially phenomenological lines[5]. This phenomenological theory allowed the correlation of experiments which appeared paradoxical from the point of view of ordinary hydrodynamics (for example, the apparently contradictory measurements of viscosity from capillary flow and the damping of an oscillating disk). Moreover, it led to numerous—sometimes rather striking—predictions which were all verified by experiment. It should here suffice to mention the long series of beautiful experiments by Kapitza[9], the temperature dependence of the moment of inertia[10], and the propagation of temperature waves (the so-called second sound)[11].

The present situation may be summed up by stating that the phenomenological theory provides a qualitatively, and partly even quantitatively, correct description of liquid helium. It is to be hoped that Green's theory with its more fundamental approach can be adjusted so as to conform to the experimental facts and to the phenomenological theory systematizing these experimental facts.

Whether or not the Bose–Einstein condensation will be incorporated into the future quantum mechanical theory is another question. Green states that "a serious objection to these theories [based on the Bose–Einstein condensation] is the occurrence of entirely analogous phenomena in superconductors, where the electrons obey Fermi statistics". Although the analogy between helium II and superconductors is very suggestive indeed, the identity of the molecular mechanisms can scarcely be considered as an established fact.

The existence of the helium-3 isotope obeying Fermi statistics provides a more reliable experimental approach to the problem of statistics. It has been recently shown that helium-3 atoms do not take part in the superflow of ordinary helium[12]. Although the definitive interpretation of this fact may have to wait until the low-temperature behaviour of pure helium 3 is known, it is perhaps premature to preclude the relevance of the Bose–Einstein condensation to superfluidity.

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I AM glad to endorse certain points which Prof. Tisza has made in his letter, especially that the behaviour of helium II cannot be explained by assuming extreme values for macroscopic parameters, and the necessity for the modification of the classical formulation of the laws of hydrodynamics and thermodynamics. It is probable that his main criticism of the rigorous theory of helium II which I have sought to develop is founded on a mistaken identification of what Prof. Born and I have called 'potential viscosity' with the 'dynamic viscosity', a rather vague concept based on an essentially classical model which was admittedly the best available until very recently. The 'potential viscosity' is for most practical purposes the difference between the viscosity of the liquid and that of the vapour at the same temperature; in helium I this has a value $\sim 15\mu$ poise, almost constant along the saturated vapour curve, as one would expect with rapidly decreasing pressure.

A detailed exposition of the application of the quantum theory of liquids to helium II has now appeared[1], and so far as I am aware it is in agreement with all of the experimental evidence. Many of the results agree with those of the two-fluid theory, and can be accepted with greater confidence than before because of the certainty of the fundamental physical basis.

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Oscillographic Observations on Ultra-High-Frequency Sparks

EXPERIMENTS are in progress on the mechanism of the breakdown of gases at centimetre wavelengths, some of which have already been reported[1]. In the previous communication reference was made to the mid-gap streamers which, at atmospheric pressure, seem to constitute the birth-stage of a spark in a resonator energized at 2,800 megacycles per second. These streamers are regularly produced when a narrow beam of short-wave ultra-violet light, from a spark gap, is passed through the gas between the electrodes immediately before the 1·4-microsecond pulse reaches the resonator (Fig. 1). Photoelectrons in the gas itself execute oscillations of small amplitude in the electric field, and cause breakdown if the field is strong enough.

In extension of these experiments, apparatus has been set up to examine the variation of the oscillating field in the resonator during the period of a pulse producing breakdown. The output from a coupling loop, *L* (Fig. 1), is rectified and amplified and is then applied to the plates of a high-speed single-stroke oscillograph. Typical tracings for breakdowns in hydrogen, nitrogen and oxygen at atmospheric pressure are shown in Fig. 2.

The most remarkable feature of these oscillograms is the abruptness of the first stage of the breakdown, which in some gases takes only about one-thirtieth of a microsecond. In fact, the time of collapse of the field is comparable with those realized in gaps of the same order (1·4 cm.) when a unidirectional voltage causes the breakdown[2]. Furthermore, successive oscillograms taken in the same circumstances show a striking consistency, and suggest, in hydrogen at least, that the delay between attainment of the breakdown voltage and actual breakdown is very small: it appears that the rate of rise of voltage does not affect

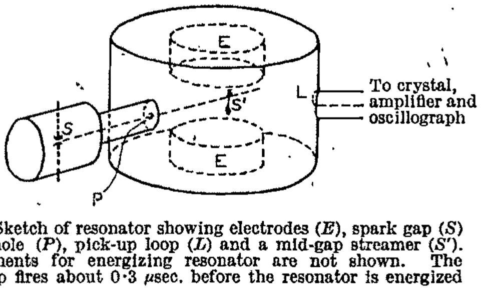

Fig. 1. Sketch of resonator showing electrodes (*E*), spark gap (*S*) and pinhole (*P*), pick-up loop (*L*) and a mid-gap streamer (*S'*). Arrangements for energizing resonator are not shown. The spark gap fires about 0·3 μsec. before the resonator is energized

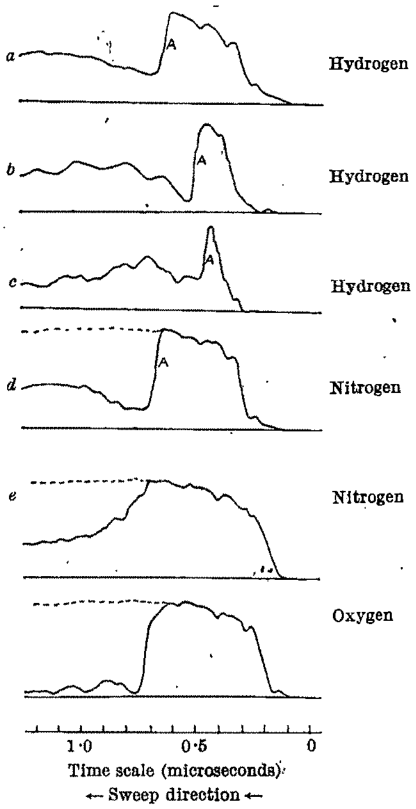

Fig. 2. Oscillograms showing collapse of field in resonator during breakdown: *a*, *b*, *c*, breakdown in hydrogen, pulse amplitude increasing from *a* to *c*, mid-gap irradiation; *d*, nitrogen, mid-gap irradiation; *e*, nitrogen, electrode irradiated through quartz; *f*, oxygen, mid-gap irradiation. Dotted lines show the unbroken pulse, obtained by cutting off irradiation (total duration, 1·4 µsec.). All observations at atmospheric pressure

the breakdown stress within the limits examined. Notwithstanding the presence of electrons in the gap, this absence of overshooting is surprising, since the measurements on ultra-high-frequency sparking potential show that the peak voltage at breakdown is less than the static breakdown voltage, usually by about 30 per cent. In such circumstances the coefficient of differential ionization, Townsend's α, should be small compared with the value in D.C. fields at breakdown; the amplitude of oscillation of the electrons should be 10^{-2} to 10^{-3} cm., and so a relatively slow development of a conducting filament might be expected, in sharp contrast with the observations.

When the initiating electrons are released at the electrode surface, using a spark outside the resonator and a quartz lens, the rate of collapse is slower (Fig. 2,*e*) and the discharge takes the form of a bright spot on the electrode surface, with a luminous tail. No difference has been observed in the breakdown stress as compared with that required to start the discharge in mid-gap.

The rate of collapse of the field in the first stage (Fig. 2,*a*) indicates that energy is being dissipated more rapidly than it is being supplied to the resonator, so that this first stage is associated with the discharge of the energy stored by resonance. The subsequent step in the oscillogram—an actual recovery in some cases—resembles the step observed in D.C. sparks by Rogowski and others[3,4].

We again wish to thank the Council of the Durham Colleges for granting one of us (W. A. P.) a sabbatical year, the British Electrical and Allied Industries Research Association for a grant towards the cost of the research, and the Director of the Armaments Research Establishment for the loan of the oscillograph.

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[1] Prowse and Cooper, *Nature*, **161**, 310 (1948).

[2] Rogowski and Klemperer, *Arch. Elek.*, **24**, 127 (1930). Buss, *Arch. Elek.*, **26**, 266 (1932).

[3] Cooper, *J. Inst. Elect. Eng.*, **94**, Pt. 3, 315 (1947).

[4] Rosenlocher, *Arch. Elek.*, **26**, 115 (1932).

Alien Plant Introductions on the Isle of Rhum

A NUMBER of very rare and interesting plants have been reported in recent years from the Isle of Rhum in the Inner Hebrides. Though Lady Bullough, the owner of the island, generously gave me permission to camp there for longer, I was unfortunately unable to spend more than three days on Rhum, and my knowledge of its flora is therefore very fragmentary. But thanks to the kindness of Prof. J. W. Heslop Harrison, who was staying on the island at the same time, I was enabled to see some at least of its most interesting plants. Of these I shall be especially concerned in this note with two only, namely, *Polycarpon tetraphyllum* (L.) L. and *Carex bicolor* All.

The first record of *Polycarpon tetraphyllum* in the Inner Hebrides ran as follows: "A single plant found growing in a rock crevice along the Kinloch Burn, Rhum; a new county record"[1]. On August 6, 1948, there were four plants in place of the original one. They were growing around the base of the outcrop of rock where the original plant had been detected. Two were large plants, bearing several rather upright stems; the other two were very small. One large and one small plant grew close together, and they were separated by a distance of some ten or twelve feet from the other two, which also grew together. From the middle of one of the two large plants, in such a way that the branches of the *Polycarpon* completely surrounded it, there sprouted a vigorous plant of *Juncus capitatus* Weig.; and there was also a small seedling that was probably of the same species. Such close juxtaposition of two exceedingly rare plants is most unexpected, even though a colony of some thirty plants of *Juncus capitatus* occurs about two hundred yards away. Beneath the other large plant of *Polycarpon* I found a very small flowering plant[2], which was eventually identified as a depauperate specimen of an alien annual *Wahlenbergia*, almost certainly *Wahlenbergia nutabunda* A.D.-C. This species seems to be unknown in Britain outside a few botanical gardens, where, however, as at Cambridge, it tends to maintain itself as a self-sown weed.

A single branch[2] of this second large plant of *Polycarpon* proved to be of a most unusual form. Its habit is strikingly different from that of the plant as it occurs in southern England, and indeed its combination of much-branched inflorescence and narrow acuminate sepals differentiates it from any of the specimens in the World Herbarium at the British Museum (Natural History). It is perhaps most nearly matched by specimens from Malta and Greece.

The above observations seem to leave little doubt that *Polycarpon tetraphyllum* is an alien introduction into Rhum.

Carex bicolor All. was first found in Britain on sparsely clad terraces above the easternmost tributary of the Allt Slugan à Choilich in the Coire Dubh, Isle of Rhum, at an elevation of between 1,250 and 1,500 feet[3]. Two separate colonies were recorded. A third colony, which I was enabled, by Prof. Heslop Harrison's directions, to see for myself, had been more recently discovered in a somewhat different locality, though still within the Coire Dubh. The following observations of this colony were made by Mr. T. R. M. Creighton and myself.

There were seven mature plants of the sedge, and also two young plants which were almost certainly of the same species. All were growing on almost bare gravel banks, at the junction of two small burns, at an altitude of about 940 ft. Two large plants were on the south bank of one of these burns, and the other seven on the north bank. Those on the north bank were fairly evenly spaced at intervals of about a foot, while the two on the south bank were several feet apart.

Of the seven mature plants one had specimens of both *Poa annua* L. and *Sagina apetala* Ard.[2] sprouting from among its leaves; two others had *Poa annua* growing in a similar way; and yet two others had *Sagina apetala*. These ruderal species, especially the *Sagina*, would scarcely be expected in such a locality. The neighbourhood, and particularly the rest of the extensive gravel banks, was thoroughly searched for further specimens of either. Though I cannot speak with complete confidence about the *Sagina* (since there was a large quantity of *Sagina procumbens* L. about, which might conceivably have camouflaged other small specimens of its congener), I fully satisfied myself that there were no other specimens of *Poa annua* in the neighbourhood.

No other arctic-alpine species accompanied the sedge; but there was, only 7 ft. from the nearest specimen of the sedge, a single small plant of *Juncus capitatus*.

The close association of annual ruderal species with *Carex bicolor*, its extreme rarity, its distribution, and the absence of arctic-alpine associates suggest that it too, like *Polycarpon tetraphyllum*, is an introduction into Rhum.

There are a few other plants recorded from the Isle of Rhum on which it is worth adding brief comments. *Viscaria alpina* (L.) Don[4] was seen growing on an unusually steep bank of rather bare stony soil at the foot of a small bluff. There are not more than a dozen plants in the whole colony, which covers an area of only a few square feet. No specimen is more than a single rosette, and even the strongest looks very weak in comparison with typical plants in Glen Clova. *Arenaria norvegica* Gunn.[1], on the other hand, is not only abundant over a relatively large area but also more vigorous than any specimens I have seen at Inchnadamph. Similarly, *Thlaspi calaminare* Lej. and Court[1], and at least two striking species of *Euphrasia*, are in considerable quantity, accompanied by an abundance of some very puzzling mossy saxifrages.

J. E. RAVEN

King's College, Cambridge.
Dec. 17.

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[1] Heslop Harrison, J. W., *Proc. Univ. Durham Phil. Soc.* (May 1939).

[2] Specimens deposited at the British Museum (Natural History).

[3] Heslop Harrison, J. W., *J. Bot.* (July 1941).

[4] Heslop Harrison, J. W., *et al.*, *Rep. Bot. Soc. and E.C.*, 707 (1943–44).

Parasitism of the Mealybug Vectors of Swollen-Shoot of Cacao

IN view of an increasing general interest in the research in progress on the mealybug vectors of swollen-shoot virus diseases of cacao in West Africa, it seems advisable to make known immediately certain factual data which are being prepared for publication in full.

The most important vector of swollen-shoot viruses, the mealybug *Pseudococcus njalensis* Laing, is naturally parasitized in the Gold Coast at a rate of about 3 per cent of the adults[1]. This rate varies considerably under the conditions prevailing in Gold Coast cacao farms, and has been shown to be consistently as low as 1·7 per cent, and consistently as high as 5·4 per cent in areas separated by only a few hundred yards. The mean rate over the past twenty months works out at 3·1 per cent for the Tafo district of the Eastern Province of the Gold Coast.

Investigations have shown that there are nine species of Encyrtid endoparasites and two species of Dipterous ectoparasites which attack *Ps. njalensis* in the Tafo district. There are statistically significant differences in the distribution of the parasite species, and in the degree of parasitism effected by a given species when its mealybug hosts are attended by different species of ants, most of which are referable to the genus *Crematogaster*.

Three of the nine Hymenopterous parasites have been determined by Mr. G. J. Kerrich, of the Commonwealth Institute of Entomology, as species of *Anagyrus*, and 73 per cent of the total adult parasites reared from mealybugs collected in the field are referable to this genus. It is of particular interest that, even when the natural parasite incidence is low, *Anagyrus pullus* Compere is still the dominant species. The two Dipterous species together account for approximately 0·4 per cent of the total parasitism, and are thus of negligible importance.

While visiting Kenya in August of the present year, one of us (A. F. P.) discussed the biological control of the coffee mealybug (*Ps. kenyæ* Le Pelley) with Dr. R. H. Le Pelley, and as a result decided to take back to the Gold Coast an efficient *Anagyrus* parasite of this species for trial on *Ps. njalensis*. Through the kindness of Dr. Le Pelley, mealybugs parasitized by a biological race of *Anagyrus kivuensis* Compere[2] were brought back to Tafo in gelatine capsules. After emergence the parasites were compared with previously determined specimens as a precaution against hyper-parasites, and males and females, usually in the proportion of 1 : 3, were transferred to 6 in. by 1 in. specimen tubes. Adults of *Ps. njalensis* were subjected to the parasites in the tubes for about twenty-four hours, and were then transferred to feed on the cotyledons of cacao beans. Afterwards, it was found to be unnecessary to feed adult mealybugs after parasitization; they were transferred to 250 ml. conical flasks, from which the transference of adult parasites was effected by fixing a specimen tube over the mouth with 'Plasticene' and darkening the flask.

This biological race of *Anagyrus kivuensis*, originally introduced into Kenya from Uganda by A. R. Melville, has now been reared through four generations on *Ps. njalensis*, and has also been reared successfully on *Ps. citri* (Risso), and on *Ps. brevipes* (Ckll.).

The discovery that one parasite of *Ps. kenyæ* will attack *Ps. njalensis* indicates that other parasites used to suppress *Ps. kenyæ* on coffee in Kenya might also be used against West African cacao mealybugs, and investigations are proceeding with this in mind.

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Dec. 14.

[1] West African Cacao Research Institute, Tafo, Gold Coast. Annual Report, 1947–48. (Crown Agents for the Colonies, Millbank, London.)

[2] Le Pelley, R. H., and Melville, A. R., "Biological Control of the Common Mealybug in Kenya", Proc. 5th Commonwealth Entom. Conference, London, 1948.

Life-history of *Bonnemaisonia hamifera* (*Trailliella intricata*)

J. Feldmann and G. Feldmann[1], when cultivating carpospores of *Bonnemaisonia asparagoides*, succeeded in getting *Hymenoclonium serpens* as the tetrasporophyte. The validity of these results, however, was challenged by Kylin[2], who supposed that the formations held to be tetraspores by the Feldmanns are in reality only end-cells which have started to divide by oblique walls typical of the adult axis. What, according to the Feldmanns, seems to be a tetrasporophyte is only a branched protonema of the gametophyte. Thus, in Kylin's opinion, there are only two phases in the life-history, the gametophyte and the carposporophyte (quoted by Drew[3]).

The problem seems to be settled by investigations we have carried out with another species of *Bonnemaisonia*. In their natural habitats *Bonnemaisonia hamifera* and *Trailliella intricata* are frequently found together. Therefore the Feldmanns supposed that *Trailliella* might be a potential part of the life-cycle of *Bonnemaisonia hamifera*. We accordingly undertook to cultivate *Trailliella intricata*. It formed reproductive organs in late autumn which are, without doubt, tetraspores (Fig. 1). Kylin's criticism certainly does not apply in this case. The spores germinating in culture developed into plants of *Bonnemaisonia hamifera* which we succeeded in cultivating until the formation of cystocarps (Fig. 2). It follows that *Trailliella intricata* is the tetrasporophyte of *Bonnemaisonia hamifera*. In order to complete the picture, it will seem to be necessary to cultivate specimens of *Trailliella* out of the carpospores of *Bonnemaisonia hamifera*. This is impossible, since no antheridia have been found in *Bonnemaisonia hamifera*[1] except in Japan. Accordingly, only in that region can carpospores be found.

As the material from which our cultures were grown was of European origin (Heligoland), we found only female plants. The very phase, however, which is lacking in our cultures is represented by the cultures of the Feldmanns. Thus the life-history of the Bonnemaisoniaceæ might be regarded as being clarified so far as the external development is concerned (diplobiontic type). Our present task, not yet finished, is to ascertain the place of meiosis. In *Bonnemaisonia asparagoides*, Svedelius[4] has found it to be directly after fertilization; we suppose that it will be in the same place in *Bonnemaisonia hamifera*.

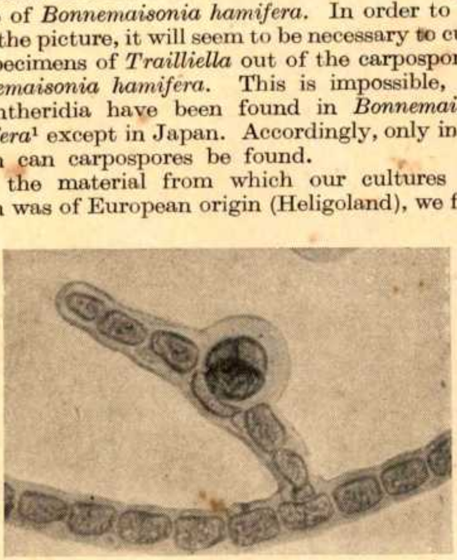

Fig. 1. *Trailliella intricata* with tetraspores in culture

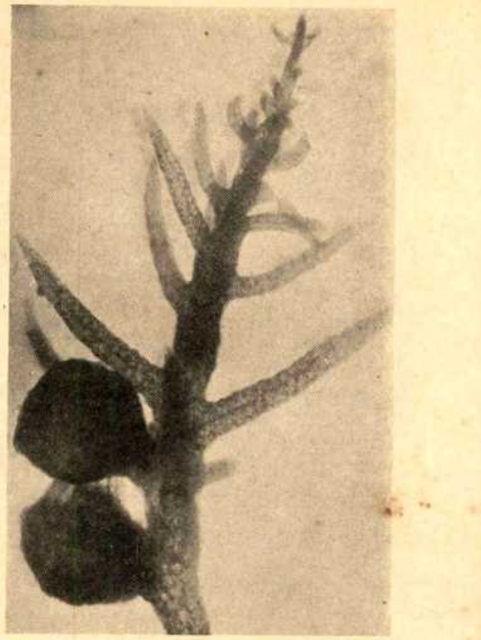

Fig. 2. *Bonnemaisonia hamifera* with cystocarps, cultivated from tetraspores of *Trailliella*

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Oct. 29.

[1] Feldmann, J., and Feldmann, G., *Ann. Sci. Nat.*, Ser. 11, **3**, 75 (1942).

[2] Kylin, H., *Acta Univ. Lund*, **15**, 20 (1945).

[3] Drew, K. M., *Nature*, **157**, 274 (1946).

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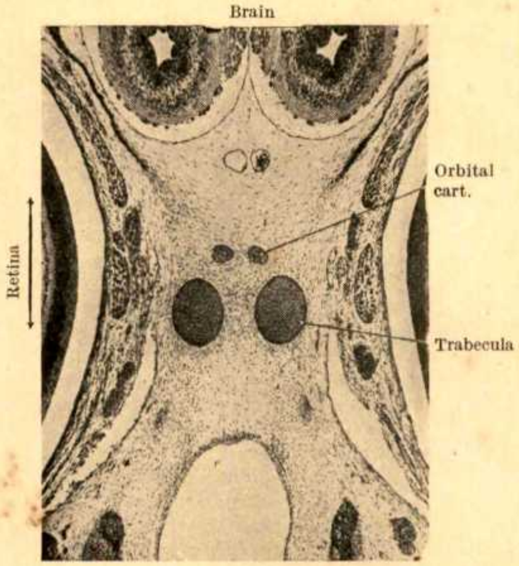
Orbital Cartilages in Snakes

IN adult snakes the trabeculæ are the only elements of the chondrocranium which are present in the orbital region. They remain paired behind the level of the nasal capsule so that the chondrocranium is platytrabic.

Parker[1], working with hand-cut sections, described and figured a pair of small unfused orbitosphenoids above the trabeculæ in the mid-orbital region of an embryo of *Tropidonotus* (*Natrix*) *natrix*. Subsequent investigators have searched in vain for these structures in embryos of several species of snakes (see de Beer[2]), and Parker's interpretation has been regarded as incorrect (Brock[3]).

During an investigation of the anterior brain-case of Sauropsida a number of embryos of different species of snakes have been examined. A 7·2-mm. head-length embryo of *Vipera berus* clearly shows two small nodules of cartilage above the trabeculæ in the



Vipera berus, 7·2-mm. head-length embryo. Transverse section through head at mid-orbital level, showing rudimentary orbital cartilages above the trabeculæ (Masson's trichrome stain, × 43)

mid-orbital region (see reproduction). The position of these nodules is similar to that of the orbitosphenoids figured by Parker in *Natrix*, and they are not connected with each other or with any other structure. The nodule on the right side has a longitudinal extent of 250 μ, and that on the left an extent of 160 μ. These structures were not found in earlier or later embryonic stages of *Vipera*, and it is concluded that they are only present for a brief period during the life of the embryo.

Only in a single instance was any comparable structure found among a large collection of other snake embryos. In a 12-mm. head-length embryo of *Python molurus*, a small nodule of cartilage was present in the midline above the trabeculæ at mid-orbital level.

Although made on different species, these observations provide some confirmation of Parker's account. It seems very probable that the structures described do, in fact, represent rudiments of the saurian orbital cartilages, and that the more extensive endocranial side-walls of lizards have some parallel in the ophidian embryo.

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[1] Parker, W. K., *Phil. Trans. Roy. Soc.*, **169**, 385 (1879).

[2] De Beer, G. R., "The Development of the Vertebrate Skull" (Oxford, 1937).

[3] Brock, G. T., *Quart. J. Micr. Sci.*, **73**, 289 (1929).

Black Rust in South-East Scotland

THE last few seasons have been notable for attacks of black or stem rust (*Puccinia graminis*) on cereals in the south-east of Scotland. The rust was particularly widespread and severe in 1947. It is possible that the rainfall and humidity of the spring and early summer being more than average, followed by a long hot period until harvest, created ideal conditions for the development and spread of the rust.

On looking into the reasons for these attacks, it soon became obvious that the common barberry (the alternate host of the rust) is frequently found in hedges, the bushes being especially numerous in the Border districts. Wheat and barley are seldom attacked to any extent; but oats are often seriously affected in the immediate neighbourhood of barberries. The straw becomes brittle and lodges rather easily, and the ears do not fill properly.

Many of the grasses are also heavily infected. In 1948 the rust was found on *Poa trivialis* and *P. pratensis*. So far as I know, this is the first record of *Puccinia graminis poæ* in Britain. Both species were growing near infected barberry bushes.

The serious losses caused by this rust in the vicinity of barberries suggest that a barberry eradication campaign in the south-east of Scotland would be most beneficial. If this could be encouraged, the losses brought about by black rust would be greatly diminished.

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White-eyed Mutants in *Calliphora erythrocephala*, Meig.

SOME months ago, Dr. P. Tate[1] gave a review of white-eyed mutants of Diptera. In his paper Tate stated that in *Calliphora erythrocephala* the male never manifests the white-eyed character.

Some years ago a white-eyed mutant of *Calliphora erythrocephala* appeared in our mass cultures, and in this case both white-eyed females and males occurred. We reared the mutant and obtained a mass culture of it. At that time, however, we were busy with other work, and so we did not investigate the mutant as to the mode of inheritance. Unfortunately, after some time the culture was allowed to die out.

It is evident that the mutation found in our culture differs from that of Tate, his mutation being sex-limited, which was not the case with ours. It is interesting to note that the same visible character may be due to different gene mutations.

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[1] Tate, P., *Nature*, **161**, 641 (1948).

Vector of Scrub Typhus in Bengal

DRS. K. V. Krishnan and R. O. A. Smith, after developing a technique for breeding *Trombicula deliensis* in the laboratory over several generations, have used these mites in transmission experiments with the white mouse as test animal, and obtained proof that *T. deliensis* larvæ are the vectors of scrub typhus in Bengal. This work was carried out at the All-India Institute of Hygiene and Public Health, Calcutta, under a grant from the Indian Research Fund Association.

DIRECTOR, Institute of Hygiene, Calcutta.

Dec. 31. (*By cable.*)

TEMPERATURE CHANGES IN HIBERNATING HEDGEHOGS

By ELSIE PROCTOR
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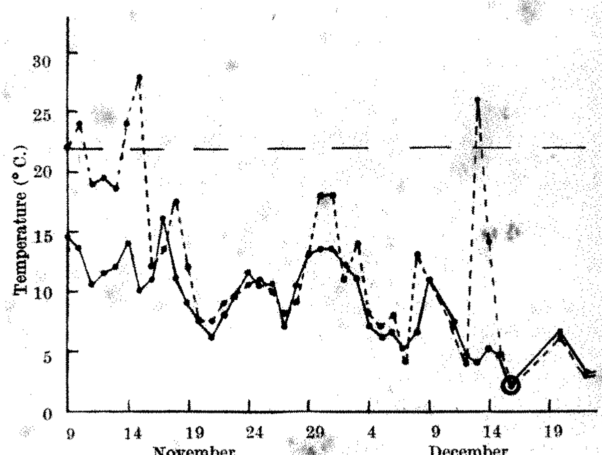
THESE records of the varying temperatures of hedgehogs during their period of hibernation, and of the relationship between these and relevant air temperatures, were made during three winters before and just after the Second World War. In pre-war days the feeding of these animals was less difficult (we used milk and eggs). Our aims were to discover: (1) whether an adequate supply of fresh food would delay hibernation; and (2) to what degree temperature changes were related to or independent of relevant air temperatures.

We have long lists of statistics covering three or four years of observation; but the integration of our results gives some fairly definite information, and a frequent recurrence and constancy of certain temperatures which seem even more significant now, in view of the fact that we are receiving some of the same recurring constants with other hibernating mammals—in particular with *Glis glis*, one of Dr. Vever's squirrel-tailed dormice.

The hedgehog, when not hibernating, is a normally homoiothermic animal with a constant summer temperature a little higher than our own (37·0° C. or 98·6° F.). During its hibernation it passes through a poikilothermic phase, that is, it becomes virtually a 'cold-blooded' animal, with a temperature which varies with that of the surrounding atmosphere. The length of this poikilothermic phase may be lengthened, as in the case of our H.3, which had not achieved its normal summer temperature by midsummer (in captivity).

Outlined below are some of our more important discoveries concerning hedgehogs 1, 2 and 3, with a graph of the temperature behaviour of H.3—which showed a remarkable recovery from the abnormally low temperature of 2·0° C.

Hedgehog 1 (*Female*). H.1 was received into a hutch in an old outside aviary on January 18, 1937. It was already in hibernation, and its temperature was 11·0° C.—that of the air in the aviary was 15·0° C. Between January 18 and March 12, 1937, we kept daily records (at 1 p.m.) of the temperatures of hedgehog and of air.



Full line, air temperature; broken line, hedgehog's temperature. — — —, line of W.T.22, waking temperature. ⊙, occasion upon which H.3 sustained a temperature of 2·0° C.

Four times during this period the hedgehog woke from hibernation, with no external stimulus except that of varying air temperature. The 'waking temperature' was found each time to be 22·0° C. (71·6° F.), and this temperature was obtained on all but one occasion only after the air temperature had risen to 12·0° C. (53·6° F.). It was observed that whenever the air temperature was recorded at 12·0° C. the animal stirred and that when its own temperature touched 22·0° C. it sought food (which was always accessible). The hedgehog is by no means a continuously 'deep sleeper' in hibernation. Even at its lowest ebb (except on the classic occasion when H.3 touched 2·0° C.) it showed slight movements of the spines in response to touch. This aggressive stiffening of the spines was our most reliable indication of life even when heart beats and breathing were imperceptible.

The blood temperature of H.1 never rose to the normal summer temperature of 37·0° C. while in captivity. At the end of March we took it back to the woods. Whether its temperature ever became normal in a wild environment we do not know, although another hedgehog (H.4) captured in July 1941 and brought in for two days observation gave us the normal summer temperature of 37·0° C., or 98·6° F. We formed the impression that hedgehogs retained in captivity during their hibernating period and afterwards do not achieve a normal summer temperature. This hypothesis was borne out by H.3, which on June 11 still remained at 32·0° C. (89·6° F.).

Hedgehog 2 (*Male*). (The winter of 1938.) The brief record of temperature readings from our second hedgehog was important from one aspect only, that the animal died and we were able to record a 'death temperature'. This was a smaller animal than H.1 and not so well nourished. We found it in deep hibernation in February and knew that it was alive from slow but perceptible heart-beats and the sensitivity to touch of the spines. On February 26 all spine reaction ceased, and at 4·0° C. the hedgehog died, and in death relaxed from a 'rolled' to a straight position. We waited for putrefaction to set in before disposing of the body. This case was amply justified when H.3 (1939–40) sank below this death temperature and revived again.

In order to facilitate references to our records we now established a series of abbreviations for the more outstanding or constant of our temperature results, as follows:

W.T.22 = waking temperature of hedgehog (constant); that is, 22·0° C. (71·6° F.).

C.T.37 = normal summer temperature (constant); that is, 37·0° C. (98·6° F.).

S.N.T.32 = subnormal summer temperature in captivity (constant); that is, 32·0° C. (89·6° F.).

D.T.4 = death temperature of H.2; that is, 4·0° C. (39·2° F.).

Hedgehog 3 (*Female*) (1939–40). Hedgehog 3, from which we obtained our most significant range of temperature variations, was a well-nourished female. We found her in a local ditch on November 9, awake but not very active. It is interesting to note at this point that the female hedgehogs (probably because of extra subcutaneous fat) appear to be better nourished and to survive winter better than do the males.

Between November 9, 1939, and the final emergence from hibernation on April 21, 1940, H.3's blood temperature rose above W.T.22 four times; but with these exceptions a state of hibernation was maintained for five months.

We retained H.3 in captivity until June 11, in an effort to record the constant summer temperature, but C.T.37 was never achieved by H.3. After April 21 until we let her go on June 11 she remained healthy, and nocturnally active, with a constant temperature of 32·0° C. (S.N.T.32).

The most startling performance of H.3 was her amazing recovery after having sustained the low temperature of 2·0° C.—two degrees lower than the death temperature of H.2. The winter of 1939 was severe, a particularly bitter December. Apart from one rise of air temperature between December 1 and 16, which dragged up the blood temperature of H.3 with it, the atmosphere became progressively colder until we recorded 2·0° C. as the temperature of both air and hedgehog on December 16.

The revival of H.3. No readings were taken between December 23 and March 1, because H.3 was presumed dead. Even spine reaction had ceased although the animal remained curled up. A student examining the hutches on March 1 stated that she believed the hedgehog to be alive, although there seemed nothing to justify this belief at the time. However, we began temperature records again, only to find that air and blood temperatures were practically similar. Since this was fairly common during deep hibernation we persisted, and at the beginning of April a slight reaction of spines was observed, and we knew H.3 to be alive. The blood temperature remained 'chained' to the air temperature until a general rise took place on April 19, 20 and 21, during which time the blood temperature of H.3 gained independence and eventually rose to 32·0° C. (S.N.T.32), where it remained constant until the release of the animal on June 11. As stated before, it never achieved a normal summer temperature in captivity.

Two other hedgehogs, H.4 (which has already been mentioned) and H.5, were studied in subsequent years. Their records helped to verify our previous discoveries.

D.D.T. AND 'GAMMEXANE' AS RESIDUAL INSECTICIDES AGAINST *ANOPHELES GAMBIÆ* IN AFRICAN HOUSES

By Dr. R. C. MUIRHEAD-THOMSON
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DESPITE the great developments in residual insecticides in the last few years, there is still difficulty in assessing and comparing their value in controlling anopheles—under African conditions at least.

The dramatic fall in the day-catch of mosquitoes in houses treated with D.D.T. is now known to be of doubtful significance by itself, and may give an entirely misleading impression that a high kill of mosquitoes has been obtained[1].

To estimate the effect on the incidence of malaria, or rather on the incidence of new infections, of large-scale treatment of African houses, is also a difficult matter, although in theory this should constitute the ultimate criterion of success. Large-scale experiments of this kind have to be planned on a long-term basis, during which time the African may be exposed several times to infection outside the controlled area. This may introduce a considerable source of error and uncertainty into the experiment, a point which has recently been emphasized by Walton[2].

It seems to me that before embarking on such large-scale experiments, the first thing is to try to find out exactly what happens inside an African house after treatment with a residual insecticide. For this purpose the technique worked out in West Africa offers the most simple and accurate solution so far[1,3].

In a study of the normal habits of anopheles in African native houses, it was found that mosquitoes leaving the shelter of the house at dusk or dawn were strongly attracted to light coming in through window and door openings. To the restless mosquito the attraction to light was equally strong during the hours of darkness, mosquitoes being attracted to the faint light coming in from the night sky. This principle was used to design a simple mud and thatch African-type hut in which two to four paid Africans slept every night. The hut was so constructed that while hungry anopheles could gain entrance through innumerable small cracks and crevices, the only light coming in from outside was through a 1-ft. square window opening, over which a mosquito netting trap-cage was fixed. Mosquitoes attracted to the light were directed into a narrowing funnel which led through a small opening into the cage. This one-way valve idea is essential, as mosquitoes trapped in the cage are attracted once more towards the darkness of the hut when bright daylight appears.

D.D.T.

D.D.T. in kerosene. As already reported[1], huts of this type were used in Lagos, West Africa, to test the effect of house treatment with D.D.T. in kerosene. Treatment of inside walls and roof at the rate of approximately 100 and 250 mgm. D.D.T. per sq. ft. afforded almost complete protection from biting for about one week. After that time, a steadily increasing number of blood-fed *A. gambiæ* and *A. melas* were taken every day in the window-traps. Among these anopheles there was no appreciable mortality in the following 48 hours. Within a few weeks of treatment, large numbers of anopheles were feeding regularly in the treated huts, were irritated by brief contact with the treated walls and roof, and were trapped in the window-cage as they attempted to leave the hut. The day-time catch of resting anopheles inside the treated hut remained practically zero for at least two months after treatment. The initial few days of complete freedom from biting was later shown to be due to the repellent effect of the heavy dose of kerosene which accompanied the D.D.T.

Possibly the first suggestion that mosquito control by treatment of houses with D.D.T. might not be as simple as it first appeared was due to Kennedy[4], who showed in laboratory experiments with *Anopheles maculipennis* that mosquitoes are excited by contact with D.D.T.-treated surfaces. In this state they were attracted to light, and could escape without having absorbed a lethal dose of the insecticide.

The field experiments in Lagos show that this irritant effect of D.D.T.-treated surfaces is a factor of such importance as to throw doubts on the value of house treatment with D.D.T. as a control measure against *A. gambiæ*.

D.D.T. dispersible powder. Recently in Dar-es-Salaam, Tanganyika, these experiments have been repeated using D.D.T. dispersible powder (1 lb. to 1 gallon of water). One particularly suitable hut was treated at the rate of approximately 400 mgm. of the powder per sq. ft. Here there was no initial period of complete protection. *A. gambiæ* were found to be feeding in the hut in numbers on the night after treatment, and from then onwards large numbers of blood-fed mosquitoes were taken in the window-trap every day. Among these there was no appreciable mortality in the following 24 hours, and a variable mortality never exceeding 20 per cent in the following 48 hours. Inside the treated hut the number of dead anopheles taken on the floor sheet was only a fraction of those escaping unharmed. For at least two months after treatment not a single resting anopheles was found inside the hut, creating the familiar illusion that a high kill of mosquitoes had been obtained.

It is possible that in some parts of the world the mere fact of driving the mosquitoes from the shelter of the house to an uncertain fate out-of-doors might achieve useful results; but in the coastal regions of East and West Africa, *A. gambiæ* normally make part-time use of outdoor resting places. As there is no scarcity of such shelters, it is unlikely that the mosquitoes are seriously affected by having to take to the open air.

Attempts were made to overcome this serious irritant property of D.D.T., such as by screening the window opening with transparent cloth treated with D.D.T., in the hope that irritated mosquitoes attracted to the light would have additional contact with the insecticide. These have not proved very encouraging, although it is still possible that the mosquito mortality might be influenced by the type of house. However, in view of the excellent results obtained with 'Gammexane' dispersible powder described below, it is doubtful if it is worth while trying to overcome these serious defects of D.D.T.

'Gammexane' Dispersible Powder

In Dar-es-Salaam, huts of the type described above have been used to test the residual insecticidal value of 'Gammexane' dispersible powder, *P.* 530. The inner walls and ceiling of a particularly suitable hut were sprayed with half a gallon of a mixture of 1 lb. powder to 1 gallon water. This worked out at approximately 400 mgm. powder, or 24 mgm. gamma isomer, per sq. ft. As with the D.D.T. experiments, not a single living anopheles was found resting in the hut for weeks after treatment; but in striking contrast to D.D.T., not a single living anopheles was taken in the window-trap up to thirteen weeks after treatment, by which time the falling mosquito population put an end to the experiment. During all that time numbers of dead *A. gambiæ* were taken on the floor sheet at every collection. Feeding still takes place inside the treated hut; but a high proportion of *A. gambiæ* are evidently killed before they can bite, especially in the first two or three weeks after treatment. Among those that feed in the hut, there is no indication of that irritation that drives them out of D.D.T.-treated houses. The window-trap catch remained very low throughout the experiment, and all anopheles found there were already dead. The continued steady figure for dead anopheles found on the floor sheet is proof of continued lethal action for at least three months after treatment.

These results are very encouraging. In persistence and killing power, this particular form of 'Gammexane' seems to satisfy the most critical requirements, and its insecticidal powers are clearly superior to those of D.D.T. Even allowing for the fact that in these huts the insecticide is being tested under ideal conditions, in which every possible resting-place for mosquitoes is heavily treated, it appears as if we now have an insecticide of real value in the control of *A. gambiæ* at least.

The success of these hut experiments is dependent on a high population of anopheles mosquitoes maintained over several months. This is an ideal not always easy to attain in the field. But when conditions are favourable it should be possible to get accurate comparisons between different dosages or different insecticides in a matter of months rather than years. The design of the hut could be modified to conform to local housing conditions without altering the main principle of the attraction to the window-trap; and it is felt that these experiments might be repeated with advantage in other countries besides Africa.

[1] Muirhead-Thomson, R. C., *Bull. Ent. Res.*, **38**, Pt. 3, 449 (1947).
[2] Walton, G. A., *Nature*, **162**, 114 (1948).
[3] Muirhead-Thomson, R. C., *Bull. Ent. Res.*, **38**, Pt. 4, 527 (1948).
[4] Kennedy, J. S., *Bull. Ent. Res.*, **37**, Pt. 4, 593 (1947).

WEST AFRICAN CACAO RESEARCH INSTITUTE

A COMPREHENSIVE account of the work of this Institute, situated at Tafo, Gold Coast, is available in the annual reports for 1946 and 1947 (Crown Agents, 4 Millbank, London, S.W.1. 5*s*.). The programme of research now being organised and undertaken includes the establishment of type collections of different varieties of *Theobroma cacao* and related species, selection and hybridization investigations, comprehensive studies of growth and cultivation, and, in particular, the study of the complex of virus diseases known as swollen-shoot, and of capsid pests, with the view of formulating measures of control.

Notwithstanding the many difficulties which have been encountered, it is evident from these reports that considerable progress is being made on a wide front and that many new facts, of great scientific interest as well as of practical importance, are being ascertained. In the matter of swollen-shoot disease, a considerable number of virus strains have now been recorded in the Ivory Coast, Gold Coast and Nigerian cacao belt, each locality showing some particularity of symptoms in the host plant. The disease has now been observed on all the main soils on which the crop is grown in West Africa. Several distinct viruses are involved, some of these not producing the characteristic stem swellings. Much useful information regarding the insect vectors is now available, and techniques have been devised so that transmission experiments can be carried out on a considerable scale. While no cacao tree immune to virus has yet been discovered, varying degrees of tolerance have been shown to occur. The virus is not transmitted by seed. That swollen-shoot disease can be controlled by cutting out infected trees has been proved; and provided the soil is suitable, cacao can be successfully re-established on areas previously devastated by the disease.

Capsids of four genera attacking cacao in West Africa are being given close attention, and their life-history, mode of nutrition, population fluctuation, and destructive effects studied. It appears from comprehensive studies that the several capsids are in the course of changing from their indigenous host plants to cacao. Spraying of young trees with nicotine sulphate has given good protection, but the method is not economic.

Soil surveys so far undertaken have shown that the incidence of virus disease or capsid pests is apparently not dependent on soil type. A preliminary general soil survey of the Gold Coast, Togo, Nigeria, and the British Cameroons has been completed, and the principal soils identified and their distribution roughly estimated. Further detailed surveys are in progress and much valuable information along several lines is being accumulated.

The reports also give accounts of the work on experimental plots in native farms, and of relevant botanical, horticultural, mycological and physiological studies.

The Director and his staff are to be congratulated on their judiciously balanced programme of fundamental and applied research, and on the progress which they have been able to report on so many interesting lines of work.

DUST AND HEALTH

SECTION V of the Conference on "Dust in Industry" arranged at Leeds by the Society of Chemical Industry met on September 30, under the chairmanship of Prof. E. C. Dodds, in the main lecture theatre of the Chemical Department of the University.

The large attendance at this section indicated the keenness of the audience for this particular branch of health hazards, although good attendance was the rule throughout all the sections.

Unfortunately Prof. R. R. Fabre, dean of the Faculty of Pharmacy in the University of Paris, was unable to be present to read his paper on "Pulmonary Penetration by Toxic Products of Industry"; but the other five communications were presented and were discussed at some length.

The first paper, by Prof. W. M. Cumming and Dr. I. A. Brownlie, was called "Tetryl Dermatitis and its Prevention". Prof. Cumming gave a review of the problem of tetryl dermatitis, which at one period proved a very serious obstacle to munition production during the War. As was pointed out, tetryl is profoundly altered in constitution by exposure to ultra-violet light, and it is only on the exposed area of the skin that the dermatitis appears. He therefore developed the interesting theory that the dermatitis was produced by the products of ultra-violet radiation actually produced over the areas of skin exposed to sunlight. He also demonstrated that these products of irradiation could combine with proteins, and it might well be that these protein complexes produced immunity reactions which were responsible for the actual dermatitis. The paper presented an ingenious attempt to bring real experimental method into the study of this very difficult subject, and the consensus of opinion at the end of the discussion was that Prof. Cumming had certainly indicated a valuable new line of approach.

This was followed by a brief paper on the subject of barrier creams. In this it was pointed out that the constituents of a barrier should be very carefully studied to see whether the particular toxic agent against which they are to form a barrier is soluble in them. The lecturer pointed out that in a number of barrier creams the constituents were actually good solvents for the toxic agents, and therefore actually assisted the penetration rather than inhibited it.

Prof. E. J. King gave a masterly summary of the present position of the study and treatment of silicosis. He described in detail the modern treatment, consisting of inhalation of aluminium powder. This again provoked an interesting discussion as to the possible danger of aluminium itself as a toxic agent.

A paper by Dr. T. A. Lloyd-Davies described the high incidence of pulmonary infections in permanganate plants. Dr. Lloyd-Davies provided evidence which supported the view that the lesion, a pneumonitis, is caused by manganese inhalation.

A very interesting review of the arsenical dusts in industry, prepared by Dr. A. N. Currie, but presented by Dr. Buchanan, showed that, despite its sinister reputation, arsenic is not responsible for frequent damage to health in industry. The question of arsenic as a cause of cutaneous cancer was carefully reviewed and discussed.

The final paper in this session was one by Prof. A. L. Roberts, on a method for determining free silica in dusts. This is a very elaborate technique for the determination of particulate crystalline silica.

The interest in industrial medicine in Great Britain was clearly demonstrated by the large attendance at this meeting, and by the really high quality of the discussion which took place at the end. It was interesting to note the complete fusion of interests of the medical workers, experimental biological workers and the actual chemists, engineers and mining engineers who operate the industries in question. There can be no doubt that the Society of Chemical Industry performed a very useful function in arranging this Conference, and it was the unanimous wish that others on the same lines should be arranged.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 17

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Francis Huxley: "The Oxford Expedition to Gambia Colony".

Tuesday, January 18

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "Art and Architecture in Science".*

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. W. E. F. Ward: "Mass Education in the Colonies".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. E. Ashworth Underwood: "The Development of Modern Physiology, 1700–1900".* (Further Lectures on January 25, February 1 and February 8.)

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Should British Universities consider the Establishment of Special Degrees in Radio?" (to be opened by Prof. E. B. Moullin).

Conway Discussion Circle (in the Library, Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Mr. Hector Hawton: "Discussion on Marxism and Intellectual Freedom".*

Society of Chemical Industry, Fine Chemicals Group (in the large Anatomy Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Discussion on "The Approach to the Chemotherapy of Tuberculosis" (to be opened by Dr. James Walker and Dr. P. M. D'Arcy Hart).

Textile Institute, Yorkshire Section (at the Midland Bank, Bradford), at 7 p.m.—Mr. Stansfield Haigh: "Hairs—their Properties and Uses".

Wednesday, January 19

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. H. Campion: "International Statistics".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. I. Morley: "Metallography of Stainless and Heat Resisting Steels".

Royal Institute of Chemistry, London and S.E. Counties Section (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Prof. W. Wardlaw: "The Ministry of Labour and the Profession of Chemistry".

Society of Chemical Industry, Plastics Group (joint meeting with the **London Section**, at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. H. V. Potter: "Synthetic Fibres—Historical Survey of the Development of some Synthetic Fibrous Materials" (Jubilee Memorial Lecture).

Thursday, January 20

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. L. J. Mordell, F.R.S.: "Rational Points on Cubic Surfaces".

Institution of Electrical Engineers, Measurements Section (joint meeting with the **Radio** and **Utilization Sections**, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. Langley Morris: "Small Power Transformers for Aircraft Electrical Equipments".

Royal Photographic Society, Scientific and Technical Group (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. A. Hughes: "The Kinephotomicrography of the Living Cell".

Chemical Society (at the Royal Institution, Albemarle Street, London, W.1), at 7.15 p.m.—Prof. F. E. King: "Three- and Four-membered Heterocyclic Rings" (Tilden Lecture). (To be repeated on Friday, January 28, at 5 p.m., in the Chemistry Department, King's College, Newcastle-upon-Tyne.)

Chemical Society, Northern Ireland Section (joint meeting with the **Local Sections** of the **Royal Institute of Chemistry** and the **Society of Chemical Industry**, in the Lecture Theatre, Department of Agricultural Chemistry, Queen's University, Belfast), at 7.30 p.m.—Sir Jack Drummond, F.R.S.: "Nutritional Theories reviewed in the Light of War-time Experience".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. H. C. Trowell: "A Critical Review of Malignant Malnutrition (Kwashiorkor)".

Textile Institute, Irish (Belfast) Section (at the College of Technology, Belfast), at 7.30 p.m.—Mr. G. Shaw: "Textile Testing Methods and Problems".

Friday, January 21

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Engineer Vice-Admiral Sir John Kingcome, K.C.B.: "Marine Engineering in the Royal Navy" (Thomas Lowe Gray Lecture).

Society of Dyers and Colourists, Manchester Section (at the Gas Department Showrooms, Manchester), at 6.30 p.m.—Dr. T. Vickerstaff: "A Study of the Factors Controlling Dyeing Behaviour".

Institution of the Rubber Industry, Manchester and District Section (joint meeting with the **Plastics Institute**, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Dr. J. R. Hetherington: "Applications of Acrylic and Vinyl Pastes".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. T. Bedford: "Environmental Warmth in relation to Human Comfort".

Society of Instrument Technology, Midland Section (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. A. J. Young: "Impressions of Recent American Instrumentation".

Society of Chemical Industry, Food Group (joint meeting with the **Glasgow Section**, at the Royal Technical College, Glasgow), at 7.15 p.m.—Dr. J. B. M. Coppock: "Some Aspects of Bakery Research".

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Mr. S. T. Pickering: "Optical Glass".

Saturday, January 22

Biochemical Society (at the British Postgraduate Medical School, Ducane Road, London, W.12), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Mathematical Assistant in the Electro-Technical Research Section at Headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1 (January 19).

Lecturer in Chemistry at the Blackburn Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (January 22).

Senior Lecturer in Physiology—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (January 22).

Superintending Geologists (2) for the Geological Survey of Pakistan, under the Ministry of Education and Industries, Government of Pakistan—The Office of the High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1 (January 25).

Senior Lecturer in the Department of Civil Engineering, University of Capetown—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (January 28).

Willow Officer at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol 8 (January 29).

Senior Member of the Staff, and a **Lecturer** (Grade III), **in the Department of Physiology**—The Registrar, The University, Liverpool (January 29).

Senior Lecturer in Civil Engineering, Natal University College, Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (January 30).

Senior Assistant in Physics—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (January 31).

Research Botanist in the Department of Allergic Disorders—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2 (January 31).

Senior Research Officer (Fibre Physicist), in the C.S.I.R. Wool Textile Laboratory, Geelong, Victoria—The Chief Scientific Liaison Officer, Commonwealth of Australia, Africa House, Kingsway, London, W.C.2, quoting No. 2063 (February 5).

Works Manager (optical), scientific and precision instruments manufacture, Ordnance Factory, Dehra Dun, Indian Ordnance Service—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting 58.L (February 7).

Readership in Mathematics at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 10).

Chemist or Bio-chemist at the Plant Chemistry Laboratory, Palmerston North—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (February 15).

Professor of Applied Physical Chemistry, and a **Professor of Inorganic Technology**, in the Institute of Chemical Technology, Farouk I University—The Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (February 15).

Assistant Professional Officer (physicist) at the Union Observatory, Johannesburg—The Secretary, Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2 (February 19).

Chair of Educational Psychology at the Institute of Education—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 24).

Chair of Biochemistry in the University of Sydney—The Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (Sydney, February 28).

Chair of Philosophy—The Registrar, The University, Sheffield (March 1).

I.C.I. Research Fellowships for research in biochemistry, chemistry, engineering, pharmacology or physics—The Secretary, The University, Edinburgh (March 15).

Director of the Institute of Social and Economic Research, University College, Ibadan, Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 (March 31).

Turner and Newall Research Fellowships for research in engineering, inorganic chemistry, physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

I.C.I. Research Fellowships for research in chemistry, physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

Statistician with experience of 'operational research' for work on strength of packages, and a **Graduate Chemist** for work on emulsification problems in lithographic printing—The Printing, Packaging and Allied Trades Research Association, Randal Road, Leatherhead, Surrey.

Lecturer in Biology—The Principal, Derby Technical College, Normanton Road, Derby.

Biochemists (2) with research experience, for work on the separation and characterization of large molecules of biological origin—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Research Chemist—Dr. A. B. P. Page, Imperial College Field Station, Silwood Park, Sunninghill, Berks.

Research Assistant to work on horticultural problems, especially those relating to glasshouses and glasshouse crops—The Curator, John Innes Horticultural Institution, 31 Mostyn Road, London, S.W.19.

Young Chemist, for research in microbiology—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2.

Electrical Engineers in the Electrical Department, Gold Coast Colony—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27324/5.

Research Assistant in Concrete Technology—The Professor of Concrete Technology, City and Guilds College, South Kensington, London, S.W.7.

Educational Psychologist—The Director of Education, Guildhall, Kingston-upon-Hull.

Assistant Professor (honours graduate) **in Mechanical Engineering**, and **Lecturers in Mathematics** (one Lecturer, with honours degree or equivalent qualification, in Electrical Engineering and one Lecturer, with honours degree or equivalent qualification in Metallurgy), at the Royal Naval College, Greenwich—The Secretary to the Admiralty (C.E. Branch 1), Admiralty, London S.W.1.

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SELECTION FOR THE UNIVERSITIES

ONE of the outstanding features of the recent report of the University Grants Committee was its concern that, in the expansion of the universities of Britain, academic standards should be maintained or even improved, and that with the increased numbers of university graduates there should be no sacrifice in quality. This implies a greatly increased supply of freshmen of high quality; although there is little direct evidence on this point, there is no doubt that the schools could supply students well in excess of the present capacity of the universities.

This position is due in part to the numbers of older students in the universities whose training has been interrupted by national service. More than a third of the students at present in the universities of Britain are in receipt of grants under the Further Education and Training Scheme, or a total of more than 28,000 out of 77,000. Nevertheless, it cannot be assumed that, when this proportion of ex-servicemen diminishes, all the places will be available for younger undergraduates. The University Grants Committee considers that a limit should be put to the present overcrowding and consequent stress and strain, and its report implies that building up again even to the present numbers, still less the completion of the recommended expansion, should wait upon the recruitment and training of university staff and the physical expansion which will permit a normal university life and the maintenance of academic standards.

Although the Working Party on University Awards appointed by the Minister of Education in April 1948 was instructed to take account of the termination of the Further Education and Training Scheme, as well as of the increased numbers at the universities, and the probable abolition of the four-year grants for intending teachers, its report* makes surprisingly little reference to this question of quality and the maintenance of standards. Its recommendations will indeed, if accepted, sweep away many anomalies and irritations in the present system of awarding State and local scholarships. It is recognized that with the increased number of scholarships, it is unlikely that, as in the past up to 1947, State scholars will all be able to go to the universities of their choice; but the majority of the 'working party' considers they should be allowed to hold their scholarships at any university to which they may gain entry. The fundamental problem, however, is not the distribution of State scholars but the selection of students as a whole for admission to individual universities; and while the 'working party' advances a proposal for a university clearing house, on which Dr. W. W. Grave has reservations, it suggests that this larger question requires careful study.

The recommendations for raising the income-level above which a parent has to pay the whole of a State scholar's expenses, namely, from £1,500 to £2,000, and for increased maintenance grants and allowance, will ease a 'means test' which at present bears heavily on middle-class families. The clarifying of the principles on which State awards are based should encourage the adoption of similar principles for local awards, and disarm some criticism of the continued predominance of the county awards. The abolition within the next three years of four-year grants to intending teachers is also recommended, in favour of provision for the degree course through the normal scholarship channels and continued finance of the students in the professional year by the Ministry.

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* Ministry of Education. University Awards: the Report of the Working Party on University Awards appointed by the Minister of Education in April 1948. Pp. iv+26. (London: H.M. Stationery Office, 1948.) 9*d*. net.

The wider implications of these recommendations, however, need to be considered much more fully. In the first place, since the local authorities are urged "to extend their arrangements to include all eligible students accepted and recommended by universities who have reached the advanced standard in two subjects in the examination for the General Certificate of Education", all financial barriers to university education are in effect down. As the 'working party' itself puts it, to-day "Reasonable opportunity exists for the ablest students to reach the university irrespective of means". With the removal of anomalies and of limitations on those opportunities as recommended in this report, it is imperative that further thought should be given to the numerical aspect, the financial cost to the State and the question of selection.

It is with this last aspect that the universities are most vitally concerned, and although the 'working party' places squarely on the universities the responsibility for recommending awards both of open and of local scholarships—that is, of selection—it scarcely seems aware, except for Dr. Grave's dissenting note, of the administrative and other implications. The universities were inadequately represented on the 'working party'; and Dr. Grave himself, in emphasizing the speculative character of the estimated figure of 5,000 given in the report for the number of places which will continue for the present to be filled by students who do not need or do not qualify for awards from public funds, suggests that the university authorities should have been consulted before this forecast was published. The basis of this estimate is the assumption that the annual intake of students by the universities will continue at a level of 18,000 as against 12,000 before the War, and that of this total at least 4,000 will be suitable candidates for open or State awards. In normal times, a further 2,000 will consist of overseas students or others who are not eligible for awards from public funds. Assuming further the discontinuance of the four-year grants for intending teachers in accordance with its own recommendations, the 'working party' suggests a minimum of some 7,000 awards to be made through local education authorities. It is this figure which is challenged by Dr. Grave, who is clearly anxious that the pressing need for university graduates will not result in a lowering of standards for admission. As he rightly observes, once standards are lowered it is very difficult indeed to restore them.

The University Grants Committee, from its recent report, is clearly fully alive to this danger, and it is to be hoped that the Minister of Education will consult the universities very fully and satisfy himself and the universities that conditions detrimental to the maintenance of academic standards are not prolonged or even made permanent by the premature adoption of a scale of awards too high for present conditions. The University Grants Committee, moreover, has the backing of the Nuffield College statement, and both bodies are far more representative of university opinion in Britain than the 'working party', only three of whose seventeen members came from the universities. If the university authorities, in the present circumstances, are unable to recommend for awards as many candidates as the report contemplates, they will have too much informed opinion behind them fairly to be accused of placing unjustifiable obstacles in the way of deserving students.

It is to be hoped, therefore, that the Minister of Education will give his support first to the proposals for the physical expansion of the universities and the provision of staff and buildings on a scale which will put a speedy term to the present overcrowding, and he can well decide that the number of public awards for 1951 shall be rather lower than the 'working party' suggests without denying a chance to anyone of real ability. In the debate in the House of Commons on December 17, the Minister of Education, while making it clear that the report had not yet been accepted, indicated that it might be concluded that the earmarking of students for the teaching profession before they entered a university would be discontinued and that, along with the considerations advanced in the debate itself, he would take full account of the representations which might come to him from the universities.

The fact that, as Mr. Tomlinson disclosed, awards are still being made under the Further Education and Training Scheme at the rate of 400 a week to students who were called up before September 30, 1947, may postpone the need for decision for a little while; but it is well to be quite clear as to what is involved in the general agreement that no one should be barred by poverty alone from a university education. As the University Grants Committee points out in its report, when the great majority of students are subsidized, it may not be possible to stop short, subject to a means test, of subsidizing all; and in spite of the difficulty of defining what is meant by "benefit of a university education", it will be necessary to face an entirely new problem of selection.

The University Grants Committee starts with the assumption that the universities must not be deprived of effective choice of their own entrants, and in this it is clearly supported by the 'working party'. The Committee also recognizes that it is desirable to exclude one type of student whom the possession of means once enabled to secure admittance —the riotously living passman, sometimes of athletic promise, on whom the university as an agency of culture made small dent. There is equally the problem of identifying at the stage of entrance to the university the other type of student, who gains much from the university and whose usefulness to the world is much enhanced by his stay there although he is not of outstanding intellectual ability. Even if, as the University Grants Committee appears disposed to agree, the removal of certain obstacles to access to the universities has eliminated also a measure of selection and lowered the average quality, the 'working party' may well be right in holding that only the adoption of its own recommendations regarding local scholarships will avoid a serious shortage of graduates for the various professions.

As to the basis of selection, the University Grants Committee merely observes that this is an unsolved problem to which the universities must now address themselves. Examination by itself will not suffice, nor will intelligence tests contribute much. Selection by interview and on the basis of reports from schools has the advantage of elasticity, but is open to the suspicion that the scales may be weighted unduly in favour of the socially eligible candidate of athletic prowess and pleasant manner and address. The 'working party' agrees that, for a considerable body of students of good academic capacity, school examinations by themselves cannot be a reliable test of ability. It suggests that the university should consider applications mainly on the grounds of the ability, attainments and inclinations of the applicants, their personality and character and the degree of competition from the other applicants. It believes, however, that more varied methods of selection are needed, and considers that the university authorities should be at liberty to interview a candidate and to apply for a suitable confidential report from the school.

Nor is this all. One other type of applicant at least, namely, those who, having left school at about fifteen and pursued their general education by part-time study, may prove to be well qualified for a university course. The 'working party' proposes that a certain number of such students should be selected on the ground of their record and intentions, supplemented by an appropriate written examination, and that the applicants should pass through a selection procedure similar in principle to that used by the Civil Service Selection Board. The final decision should rest not with the testing board but with a final selection board, constituted by the Ministry of Education, and on which the universities would be represented. This scheme would obviously remove the disadvantage at which such part-time students are placed in the ordinary written examination, and the 'working party' wisely suggests that the scheme should be tried at first on a very small scale. Dr. Grave objects to universities being asked to accept the recommendations of any final selection board, apparently basing his criticism on the Ninth Report from the Select Committee on Estimates (Session 1947–48), which discussed the Civil Service Selection Board (London: H.M. Stationery Office, 203, 205; 1948. 2*s*. net).

The selection of university students was one of the points made in the Fabian Society report, "Universities and the Future", in October 1947 (London: Fabian Publications, Ltd. Fabian Research Series, No. 120, pp. 33. 1*s*. net). Discussing the question, "Who Shall Graduate ?", it is emphasized that a comprehensive scholarship system is also essential to ensure that, whether the universities expand or not, they recruit the best possible material and draw fully upon the country's reserve of talent. The report accepts more readily than the University Grants Committee the opinion of the Barlow Report that there is an ample reserve of intelligence in Britain to allow both doubling university numbers and at the same time raising academic standards. No opinion appeared to be expressed on this point at the discussion in Section L (Education) of the British Association meeting at Brighton on "Selection at the University Level" (see *Nature*, October 16, p. 626); but successive speakers recognized the difficulty of finding a solution for the problem, and also the need for an experimental approach.

This, however, is not all. Whatever method of selection may be devised, its adoption by the universities of Britain will involve heavy administrative responsibilities with which many of them are at present ill-staffed to cope. No doubt the University Grants Committee was not unmindful of this aspect in its observations on administration; but the magnitude of those responsibilities may well be a further reason for proceeding with caution. The points at issue, in fact, are essentially those of method and of timing, and the whole trend of the Minister of Education's remarks in the recent debate on university awards suggests that the recommendations of the 'working party' will not be implemented hastily or without due forethought and proper consultation of the universities, the weak representation of which on the 'working party' has rather diminished the weight of its recommendations. If that course is adopted, we should simultaneously be on the way to the thorough understanding between the universities and the schools which Mr. C. R. Morris rightly stressed at Brighton, and which Dr. J. F. Mountford had previously urged at the Home Universities Conference in September 1947.

A FORGOTTEN HISTORY OF BOTANY

Botanik der Gegenwart und Vorzeit in culturhistoricher Entwickelung

Ein Beitrag zur Geschichte der abendländischen Völker. Von Karl F. W. Jessen. (Pallas, Vol. 1.) Pp. xxii + 495. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1948.) 6 dollars.

THIS volume is the first of a series of classical scientific works which the Chronica Botanica Company aims at bringing into fresh circulation. Jessen's book appeared in 1864, eleven years before the publication of the well-known "History of Botany" by Sachs; but, while a copy of the original or of the English translation of the latter is to be found in every botanical library, Jessen's book will be known to very few in Britain. In actual fact the two books supplement one another to a very considerable degree, for, whereas Sachs' history begins with the early sixteenth century and gives little insight into the state of knowledge about plants among the ancients and during the Middle Ages, the first ten chapters of Jessen's book are devoted to these matters. After a brief consideration of the little that is known of plant studies among the early Indians, Egyptians and Babylonians, successive chapters deal with the state of botany among the Greeks and the Romans, during the early Christian era in Eastern and Western Europe and among the Arabs. A further four chapters dealing with the commencement of scientific studies in Western Europe brings the consideration to about the middle of the sixteenth century.

Jessen's book is, moreover, not a mere history of botany, but relates the progressive development of knowledge about plants to the general state of culture and of science as a whole at different periods. In fact, several of the earlier chapters contain as much information on the social history of the time as on the momentary state of botanical knowledge. It is this cultural approach that, as the editor remarks, renders Jessen's work unique. It carries with it also a different treatment of the subject-matter, since, in place of the separate consideration given to morphology and classification, anatomy and physiology by Sachs, Jessen in general discusses the state of the subject as a whole in each historical period.

The last ten of the twenty chapters into which the book is divided deal in the main with botanical history during the post-reformation period ; in fact, one is devoted to the re-orientation of science which followed in the sixteenth and seventeenth centuries. The gradual development of systematic botany from its early beginnings to the middle of the nineteenth century is admirably traced and illustrated in tabular form at the end of the book, while other branches of botanical science receive a due share of attention, but are not as fully treated as in Sachs' history. The excellent chapters on agriculture and horticulture and on popular science and botany in the eighteenth and nineteenth centuries are part of the special framework of the book.

Jessen's history is very readable, and usually succeeds in avoiding long lists of names which tend to become tedious. Those who have contributed the lion's share in the advancement of botanical knowledge occupy the foreground, and due credit is given to the part played by the various European countries in this process. A list of botanical journeys and a good index add to the value of the work.

F. E. Fritsch

THEORY AND PRACTICE OF SUPERCHARGING

Supercharging the Internal Combustion Engine

By Prof. E. T. Vincent. Pp. viii+315. (New York and London : McGraw-Hill Book Co., Inc., 1948.) 30*s*.

PROF. VINCENT has written an excellent book and is an enthusiastic exponent of his subject. The fundamentals of all aspects of supercharging are dealt with, and although the major part of the book is devoted to aircraft practice, there is much that is applicable to all forms of supercharged engines, including a chapter on the Diesel engine.

The author states in the preface that he is writing for "persons not directly connected with the theory or development of superchargers" ; the needs of such persons are adequately catered for. Those interested only in air compressors will find that the chapters on these machines form a comprehensive text-book in themselves. The types of compressors described include reciprocating, rotary constant displacement, centrifugal and axial flow, and an account of the theory of each is given. An interesting chapter on surging in the centrifugal compressor is included. The subject of supercharging itself is dealt with fully, and there are chapters on the theory of the supercharged engine cycle, performance estimating, testing, engine-driven superchargers and turbo-chargers. The book is profusely illustrated with diagrams and photographs, and a number of useful charts of the properties of combustion gases are provided.

In an early chapter on thermodynamics the author shows a nice appreciation of what should properly be left out of a book of this type, where the emphasis is on applied rather than fundamental thermodynamics. In no less than three places the reader is advised to consult a text-book of thermodynamics for a more rigorous treatment of certain points, such as the statement that entropy and internal energy are functions of the state of a body. Obviously, full discussions of such questions are outside the scope of this book, and the author has been very wise in not allowing himself to become involved in them. It is a pity that more authors do not follow this example. On the other hand, difficult problems which are not usually found in text-books on thermodynamics are not shirked. Steady flow, for example, which is of fundamental importance to engineers and which is treated inadequately, if at all, in most text-books, is fully discussed.

E. G. Sterland

GEOLOGY OF THE LIZARD DISTRICT

Memoirs of the Geological Survey of Great Britain

England and Wales. Explanation of Sheet 359 : Geology of the Lizard and Meneage. By J. S. Flett and J. B. Hill. Second edition, by Sir John Smith Flett. Pp. xi+208+11 plates. (London : H.M. Stationery Office, 1946.) 7*s*. 6*d*. net.

THE Lizard district had long been famous as a field of geological research and controversy prior to the publication in 1912 of the Geological Survey Memoir on it, and on many of its petrological, structural and stratigraphical problems there was scarcely a general consensus of opinion. This second edition, by the late Sir John Flett, one of the original authors, reveals him in the full maturity of his scientific judgment and mental vigour. It has been entirely rewritten after a re-examination of the area that followed his retirement from the directorship of the Geological Survey in 1935. Many will visualize in these accounts of the cliffs and exposures "alongside the path leading from the hotel to the beach" that powerfully built figure with deliberate step and penetrating all-embracing eye.

The new edition of the one-inch geological map which appeared in 1934 contained substantial changes in the age-grouping of the sedimentary rocks, which resulted from Prof. W. H. Lang's attribution of a Devonian age to the plants assiduously collected by Miss E. M. Lind Hendriks, and from Dr. C. J. Stubblefield's recognition of supposed Ordovician *Orthis* as a Devonian *Chonetes*. The significance of these changes is fully discussed. Regarding the age of the best-known Lizard rocks—the serpentines, gabbros and hornblende schists—Sir John ably presents the evidence; but generally reserves judgment.

The geological description is reduced from 263 pages in the first edition to 178 pages. In the introductory sections, geomorphology and soils receive considerably fuller treatment, and the interrelation of these with the underlying rocks is stressed throughout. These beneficial changes, the incorporation of new material, and the doubling of the number of text figures, especially maps, has, of course, involved the elimination of much detailed descriptive material. Lucid general descriptions and balanced critical discussion are preferred. The result is a combination of simplicity, clarity and scientific accuracy in a high degree. It may be that this work will be considered as representing what the eminent author in the fullness of his administrative and scientific experience regarded as desirable in an official memoir. Nevertheless, because of the elimination of much detailed description of important exposures, it might still be claimed that the old edition remains a valuable work of reference. A reservation should therefore be made that this effective compromise between a rather heavy, fully documented memoir and a much shorter explanatory guide does not necessarily represent a precedent of general applicability.

THE ART OF GRAFTING PLANTS

The Grafter's Handbook

By R. J. Garner. Pp. 223 + 24 plates. (London: Faber and Faber, Ltd., 1947.) 15*s*. net.

IN no branch of horticulture has so much ingenuity and manual dexterity been shown as in the art of grafting and budding. Over centuries, gardeners have taken pride in devising new methods by which two or more plants of different origin may be made to combine into a single entity, often for no reason other than to show their skill or originality, though sometimes to improve genuinely upon existing methods. Mr. R. J. Garner has probed deeply into the literature to discover as many of these ingenious devices as seemed to him worthy of preservation, and out of many hundreds he has put on record some eighty-odd methods of grafting, including a dozen or more of budding. All, or nearly all, are accompanied by unusually clear line drawings of the stages in each method, which help greatly to make plain the description in the text. If the book did nothing but bring together these scattered records and preserve them in collected form, it would have achieved something of historical value.

But the author is far more than a seeker into the past; he is a practical propagator of twenty years experience and a scientific man at the same time, and he has used his experience and his critical faculties to bring out the value of particular methods in particular cases and to show how a recondite or unusual means of manipulation may have a scientific justification in special circumstances. More than that, he has brought together the most up-to-date findings of research and the best traditional practices in the field of propagation as a whole, for he deals not only with the methods of grafting *per se*, but in the earlier chapters he also describes the methods of root-stock propagation and scion-wood preparation, which involves a discussion of many aspects of the problem.

The book is one which must be of the greatest value to the professional horticulturist, the amateur, and the student, all of whom will find in its pages not only guidance in technique but also clear exposition of underlying principles. A word of praise is due to the printers and publishers for the admirable type and format and, above all, for the clarity of reproduction of the author's own exceptional drawings and plates. Only too often photographs in a book of this type serve little useful purpose, other than presumably to increase the sales-value of the book; in this case every plate is a valuable illustration of some special point.

R. H. STOUGHTON

THEORY OF THE STRENGTH OF METALS

Report of a Conference on the Strength of Solids (1947)

Pp. 162. (London: Physical Society, 1948.)

THIS volume is a collection of papers given at a conference in Bristol in 1947 (see *Nature*, **160**, 696; 1948) together with a few additional papers. The solids dealt with are almost exclusively metals. The volume is divided into four parts of unequal length under the headings: "Creep and Plastic Flow" (70 pp.), "Grain Boundaries and Recrystallization" (47 pp.), "Precipitation" (20 pp.), and "Fracture" (4 pp.). The papers of the first part are concerned mainly with the deformation of metals associated with movement of dislocations. Dislocation theory has made good progress since the previous Bristol conference in 1939, and in the present volume many of the mechanical properties of metals are plausibly explained in terms of dislocations. The suggestion that solute atoms, such as carbon and nitrogen, may migrate to the neighbourhood of dislocations and hinder their movement gives an interesting interpretation of the yield phenomena in mild steel; and a first treatment of dislocation dynamics gives a plausible explanation of the multiplication of dislocations necessary to explain deformation by gliding. An interesting account is given of an electron microscope and diffraction investigation of slip in aluminium crystals. A notable omission is that a section, containing nine papers on creep and plastic flow and another of six papers on grain boundaries and recrystallization, should contain no papers on grain-boundary creep. The third section contains some good work on hardening of metals by the oxidizing *in situ* of solute atoms having a sufficient affinity for oxygen, and also a paper on the trapping of electrons in silver chloride, which raises the possibility of photographing dislocations.

In a volume entitled "The Strength of Solids", it is surprising that so little attention is given to fracture, and it leaves the impression that even the elements of a theory of the fracture of metals has yet to be given. Nevertheless, in view of recent progress in the study of the plastic properties of metals, we may look forward to a report on a not too distant conference on the strength of metals which does not belie its title.

C. GURNEY

TRYPANOSOMIASIS IN AFRICA

IT is not always possible to contemplate with such pleasurable anticipation a series of Government publications such as those dealing with varied aspects of trypanosomiasis in Central Africa—a truly gigantic problem. This is discussed in the four important communications now published*. These reports form a series prepared for the Tsetse Fly and Trypanosomiasis Committee appointed by the Secretary of State for the Colonies and edited for publication by the staff of the Bureau of Hygiene and Tropical Diseases. It is right that it should be emphasized that this difficult task has been performed with that thoroughness and skill which are the hallmarks of this excellent institution. By so doing they have been embellished with a scientific *finesse* which will be appreciated all the world over.

The vastness of the trypanosomiasis problem which confronts the Colonial Governments and the Colonial Office to-day is emphasized in a popular appreciation. The havoc caused by tsetse flies in Nigeria, for example, extends over a country seven and a half times the size of England, so that one-fifth only of this huge territory is safe for men and cattle. On the Gold Coast, over the entire area of 91,840 square miles, these flies prevent the people from keeping the large-humped zebu cattle which should contribute enormously to their meat supply; thus they are compelled to rely upon their own native dwarf unproductive breed which is more resistant to trypanosomiasis. The third great West African Colony —Sierra Leone (27,500 square miles)—is quite over-run with tsetse, and endemic sleeping sickness in man occurs in one-tenth of the country, so that the same dire cattle problems present themselves and large numbers succumb to this disease. Though comparatively smaller, the whole of the Gambia (4,130 square miles) is infested with tsetse, while human sleeping sickness is sporadic; but nowhere can the larger and more economic cattle types be maintained.

One of the more drastic remedial measures which have been suggested is the extermination throughout 'fly country' of the numerous dog-faced baboons upon which these flies engorge themselves—a task more easily said than done.

In Uganda we learn of extensive pastoral areas which, some forty years ago, maintained flourishing herds of healthy cattle and now are clothed with impenetrable bush. In one epidemic, within three years, 200,000 natives, inhabitants of Busoga Province, were exterminated. To those who study the food problems of the world—and there are many at the present moment—it comes as a shock to learn that in all the East African Colonies there are said to be only some 14 million head of cattle to support more than 15 million people, and that this deplorable disproportion is to be ascribed to the tsetse fly alone.

The bionomics of some ten species of *Glossina* are dealt with in these reports. This is a field to which British entomologists have devoted special skilled attention. Each species has its own particular habitat and maintains its own peculiarities. Some can tolerate extreme ranges of humidity and temperature, whereas others avoid dry zones. Some thrive in the forest shade, others avoid it. Most of this information is contained in the exhaustive report by Dr. T. A. M. Nash—a document of some seventy-five pages, illustrated by sixteen topographical photographic plates, of outstanding excellence, and an appendix containing fifteen beautifully executed maps, which we understand are the most accurate and detailed ever published on this subject.

The largest of the West African cattle—the humped zebu—is the breed with the least resistance to trypanosomiasis, so that it cannot be kept in belts where *Glossina morsitans* abounds; therefore, bovine trypanosomiasis is most serious in northern Nigeria, where these cattle are dominant.

The riverine tsetses, *G. palpalis* and *G. tachinoides*, carry most of the sleeping sickness to man. The bulk of this human disease occurs in the savannah woodland zone and, broadly speaking, the disease appears to be absent from the main forest belt. Eradication of the tsetse with the means at present at disposal is a Herculean task, and it is not possible to go deeply into this subject. In short, it involves the clearing of vegetation against the tsetse, as each particular species preserves its own peculiar botanical association and only too often do these radical measures clash with the interests of the agricultural and forestry departments. This is gathered from Nash's own story of the Anchau Rural Development and Settlement Scheme. Here is unfolded a tale which should warm the heart of all true patriotic Britons. The Anchau district is in the Zaria province of northern Nigeria, where in 1934 it was found by Dr. N. E. W. Anderson that no less than one-third of the population had sleeping sickness and that the bulk of the area was infested by *G. tachinoides* The Anchau settlement is the first large-scale attempt at rural development to be made in British West Africa, and marks the first occasion in that country in which the fly has been eradicated from a corridor 70 miles in length and covering an area of 712 square miles. The carrying through of this complete scheme has occupied some ten years and has entailed the co-operation of the Forestry, Veterinary and Geological Departments of the Nigerian Government. The scheme has now been completed at the comparatively cheap cost of £95,000 spent over a period of five years. That it has been well spent, and that it has afforded a demonstration of paternal Colonial Government in the best sense, a study of this fascinating account amply proves. In the Anchau district 3,700 people were moved out of 200 square miles of country, and eventually the whole population of 13,000 was settled into an area of 170 square miles.

We are given a glimpse of a primitive African town. It was indescribably filthy. Some 2,500 lived within a town wall which surrounded only 0·118 square mile, giving a population density rate of 21,200 to the square mile. On the weekly market days, about three thousand additional visitors would crowd into it, constituting a seething mob, all coughing, sneezing and spitting, owing to the peppers on sale in the tumble-down booths, so that any of the prevalent diseases spread rapidly to the surrounding villages after market days. The town was traversed by sunken footpaths winding between high mat fences, ankle-deep in expectorated sugar cane. Wooden clogs were worn because of the mud. Stinking borrow and dye pits mingled their smells with the all-prevailing stink of human excrement. For defensive reasons the town had been built on the edge of a marsh, with two tsetse-infested streams on the west and south and, in addition, these flies swarmed in the thicket-choked moat of the town wall which the people refused to clear because of ancient superstitions—but it *was* cleared and Anchau has survived. Mosquitoes came up at dusk from the marsh in their myriads. For years all beasts had been slaughtered on a piece of blood-soaked ground, which was littered with offal and bones, thereby providing a meeting-place for vultures and hyænas, and the dead had to be buried inside the town, to prevent desecration by these ghouls. In the wet season, the guinea corn, fourteen feet in height, choked the few remaining open spaces. Water was obtained from the swamp or from filthy wells sited within a few yards of a pit latrine.

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* Colonial Office. Tsetse Flies in British West Africa. By Dr. T. A. M. Nash. Pp. 78+15 maps. 30*s*. net. The Anchau Rural Development and Settlement Scheme. By Dr. T. A. M. Nash. Pp. 22+4 plates. 3*s*. 6*d*. net. Trypanosomiasis in British West Africa. By Dr. T. H. Davey. Pp. 15. 2*s*. net. Trypanosomiasis in Eastern Africa, 1947. By Prof. P. A Buxton. Pp. 44. 3*s*. net. (London: H.M. Stationery Office, 1948.)

Such is the lurid picture painted of old Anchau, the district headquarters. How all this has been changed, how a model township with brick-built bee-hive huts in model compounds, with standard types of new wells, spacious well-planned market-place, slaughter-houses, etc., has been built, are well illustrated by a series of excellent aerial photographs. There follows a number of suggestions from the lessons which have been learned. More than 18,500 fruit and shade trees have been distributed throughout the corridor. A successful pig-breeding industry has been started which brings much wealth to the peasant farmer. Tsetse have been eradicated from 610 square miles of country, necessitating the clearing of 540 linear miles of stream, so that now some 50,000 people can live out healthy lives in a tsetse-free country.

There are some amusing interludes, such as the conflicting interests between the afforestation enthusiasts and tsetse-minded entomologists. Thus the planting of innocent papaya trees provided an ideal breeding place for *G. tachinoides* in the middle of the town and they had to be cut down. The presence of sacred trees in the streams caused much trouble. The village headman would suddenly announce that the work was nearing a spot where any man would die who entered the grove, and then work would come to a standstill. This nuisance was soon avoided by inducing the old man to exorcise his evil spirits on to a neighbouring hill, when everyone appeared to be satisfied and the prestige of the gangman was proportionately enhanced. To mark the transition from the bad old days and the transformation from a sink of pestilence, the new town of Anchau has been named Takalafiya,' which means "Walk in Health".

Dr. T. H. Davey's "Trypanosomiasis in British West Africa", a rather shorter document of some 15 pages, includes a general survey of West Africa and embraces the Anglo-Egyptian Sudan, French West and Equatorial Africa, the Belgian Congo and Liberia. Though not so detailed as the other reports, it contains a summary of useful information both on human and cattle trypanosomiasis.

In Prof. P. A. Buxton's "Trypanosomiasis in Eastern Africa, 1947", we are presented with a somewhat different problem. Many important points are discussed in the author's own characteristic and philosophical manner in a series of 275 paragraphs and in a space of 44 pages. The situation in East Africa differs in many important particulars from that in the West African Colonies. The geographical features of mountains, valleys and fertile plains present an entirely different picture with its own peculiar vegetation and fauna. Whereas sleeping sickness is conveyed from man to man direct by tsetses in the west, here the human disease is interconnected with big game and the fly which is their constant companion—*Glossina morsitans*. The cattle problem is even more serious, because the wild animals constitute a reservoir of trypanosome infection for them.

The fact has to be faced that, until some better preventive measures are devised, cattle and big game cannot co-exist. An alarming feature is that no doubt serious advances of the fly have recently taken place, especially by the closely related 'game tsetses' (*G. morsitans, G. pallidipes and G. swynnertoni*). This last-named insect was discovered by the late C. F. M. Swynnerton, who was the first to undertake tsetse survey, research and reclamation in Tanganyika in 1921. Swynnerton was a remarkable man, essentially a good naturalist, without any scientific training; but he possessed an immense knowledge of insects, game, plants and Africans, and he could envisage in his own mind the whole problem in a manner no one else has ever attained. More recently, particularly in Tanganyika, field workers have begun to mark flies with spots of paint. This has led to knowledge about their length of life under natural conditions and the distance covered by a fly. A system was then developed, depending on the use of more than one colour, applied to particular spots on the fly, so that it was possible to indicate where and when the fly was first caught, together with information about recaptures. By the use of these methods, entomologists were able to unravel the habits of *Glossina*. They showed that they had particular breeding places, feeding places and resting haunts, and they were able to determine these in terms of characteristic trees and bushes. Much interesting work has been done on the biology of *Glossina morsitans*. This insect lives in a large number of types of vegetation in different parts of its distribution. The greatest part of its range is in 'miombo', a thin deciduous woodland, composed of many types of tree, especially *Isoberlina* and *Brachystegia*; but in other parts it frequents *Acacia* thorn bush, whereas in Ankole, Uganda, it lives in thickets of thorn and other trees growing on large ant-hills in open grassy plains. In all these diverse environments the insect exercises a precise choice, and only feeds, rests or deposits larvæ in very limited spots. It is reasonable to believe that this precise choice, which renders discriminative clearing possible, is partly due to micro-climate.

In Central and North Africa, conditions are generally simpler than in East Africa. The immense geographical variety of Kenya and Uganda, with their high mountains, rift valleys, coastal plains and so forth, is absent. Although *G. morsitans* is the dominant species, yet *G. pallidipes* is also dangerous and has been overlooked in certain areas.

Entomological work in East Africa has been mainly directed from the Tsetse Research Department, Shinyanga. This has already resulted in the settling of large areas in Tanganyika which were formerly occupied by tsetse. The total area reclaimed by this Department is 1,300 square miles. There are now, in the Shinyanga district, 175,000 tax-payers and 525,000 cattle. It is an impressive experience to fly, as Buxton has done, over this area and see cattle and grass and villages where there was at one time only bush and tsetse.

In Uganda, successful control of *G. palpalis* by clearing its waterside breeding places has been practised for many years. Some of these clearings are important because they protect considerable centres of population, especially Entebbe, and they also render safe the ferries where numbers of travellers used to be exposed to the bites of this fly.

The control of tsetse in Southern Rhodesia is essentially a battle against *G. morsitans*. It is the problem of protecting cattle. The principal method employed has been the eradication of game from certain areas, mostly in the higher regions of this territory. Here the Government proposes to make a total of 300–350 farms, each of 3,000 acres, which will be on land formerly occupied by *G. morsitans*.

It has only been possible to select a few of the most important and interesting features which are presented in this most remarkable and original document; but it may convey to the uninformed reader a small idea of the immense effort, both physical and mental, that has been expended by a handful of enthusiastic scientific workers for the benefit and development of the Dark Continent.

It is by a happy coincidence that a summary of this fine preventive work should be published at this very time, furnishing, as it most certainly does, an appropriate setting to the introduction of 'Antrycide', a discovery published in *Nature* of January 15. Together they form a fine consummation of the work of this team of British scientific workers, and undoubtedly bring eventual victory over the tsetse considerably nearer. This is an achievement of which everyone who is interested in the welfare of Africa should be proud, although its full import cannot as yet be measured.

Finally, we venture to assert that these reports, so inadequately here reviewed, constitute a model for the world to emulate. By our good deeds shall we be judged by future generations. Scientific work of this calibre forms the kernel of potent propaganda. We can therefore look forward to such time as the British representative, at some stormy meeting of the United Nations Organisation, can confront his detractors with these mighty African achievements, for no other nation, by its self-effacing and patient labours, has done so much for the health, prosperity and well-being of the untutored Africans whom fate has placed under its care.

PHILIP MANSON-BAHR

BEE BEHAVIOUR*

By DR. C. G. BUTLER

Rothamsted Experimental Station, Harpenden

FOR many years it has been realized that a well-developed social organisation is exhibited by every colony of honey-bees. We now know, thanks to the work of G. A. Rösch and others, that a highly efficient division of labour exists among the worker bees of a colony, and that each worker bee has her own particular part to play in the economy of her colony. The nature of the duty which a worker performs at any given time is very largely, but not entirely, determined by her age, or, more correctly, by that state of physiological development to which she has attained at the time. But there are no hard and fast rules. If insufficient bees of nursing age are present to feed all the larvæ properly, the period of nursing is extended; similarly, if more than sufficient house-bees are present, their time is not wasted, and the position is readjusted by surplus house-bees becoming foragers at an earlier age than usual. The precise mechanism by means of which such adjustments are made is not yet fully understood.

By the time a bee is three weeks old, she knows the exact position of her hive relative to neighbouring objects in the apiary. If we take a bee of this age and release her a short distance away from her hive, she finds her way home largely, perhaps entirely, by sight. Later, however, as shown by the work of E. Wolf, when she becomes an established forager, two further senses come into play and aid her in finding her way back to her hive. These are a sense of distance travelled, and a sense of the direction in which she has travelled on her outward journey to a source of food.

Even after a bee has successfully relocated her hive on her return from a foraging expedition, she may experience considerable difficulty in finding the entrance if it has been altered in any way. For example, as shown by Butler, if the hive is turned through 90°, she will return to the exact place where the entrance has been hitherto. She settles on the nearest part of the hive to this position and proceeds to run about in all directions, frequently taking to the wing and re-alighting on the place where the hive entrance was situated previously. Eventually, after much running about she locates the entrance in its new position. On her return from subsequent foraging expeditions she does not go directly to the entrance but always goes first to the place where it was originally sited, alights there and runs round on the outside of the hive to the entrance in its new position. Ultimately she learns to fly round to the entrance, but never does so directly, always flying to its original position first and flying from there round the hive to its new location.

In a very similar manner to that in which she is able to find her hive on returning from the field, the honey-bee is also able to relocate a dish of sugar syrup or other source of food that she has found in the field. Provided that the source of food has not been moved, or its surroundings disturbed, the average honey-bee relocates it quickly and unerringly after she has visited it a few times. Let us suppose, for example, that we have placed a dish containing concentrated sugar syrup a short distance, say fifty yards, in front, north, of a fairly strong colony of bees living in an observation hive. It will almost certainly be a matter of hours or even days before a single bee finds the syrup. When a bee does find the dish, however, she settles upon it and proceeds to fill her honey stomach before returning to the hive with her prize. When she leaves the dish she performs a short orientation flight around it to help her to find it again the next time that she seeks it. Let us mark her with a spot of coloured paint so that we can recognize her again. If we watch her on her return to the observation hive, we find, in all probability, that she performs a little dance either on the alighting board of the hive or on one of the combs, every now and then pausing to pass some of the syrup that she has collected to other bees that have been paying close attention to her dancing. Presently, when she has given away the syrup she has collected, some to the house-bees for ripening and storage, and some to the bees of foraging age, she ceases to dance, cleans her eyes and antennæ, and leaves the hive, soon to reappear at the dish of syrup. A number of bees will have been observed to have been attracted by the dance, and some of them leave the hive while the dancer is still performing and eventually find their way to the dish of syrup, so that the number of bees visiting the dish increases. It will be realized that by means of the dance the bee that had found the syrup in the first place was able to communicate information concerning its existence to other bees. Some of these bees then left the hive to seek the syrup and, having found it, filled their honey-stomachs, made orientation flights around the dish to aid them to relocate it on future visits, returned to the hive and danced in their turn, thus informing other bees of their find.

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* Substance of a Friday Evening Discourse delivered at the Royal Institution on November 5.

After a number of bees have found the dish fifty yards due north of the hive and have been marked so that we can recognize them again, let us put out further dishes of syrup of exactly the same concentration, west, east and south of the hive and fifty yards from it in each case. We then find that just as many fresh bees appear at each of the new dishes as appear at the old dish due north of the hive. Thus we see that, so far as we can tell, all the information that the dancing bees were able to convey to their sisters was that syrup was to be found somewhere outside the hive. They did not lead the newcomers to the syrup either by flying along in front of them, by leaving a trail of scent, or anything of that kind. Now let us repeat the whole experiment, except that we add a few drops of perfume, let us say oil-of-lavender, to the first or training dish due north of the hive. Plain unscented syrup is supplied in the other three dishes when they are put out. We now find that all the newcomers collect at the first or training dish only, ignoring the other dishes which contain unscented syrup of the same sugar concentration. It is clear, therefore, that by means of the scent in the syrup which the dancing bees gave to those bees which were attracted by their dances, the dancers were able to communicate to the other bees information concerning not only the presence of desirable syrup somewhere outside the hive, but also the scent associated with the syrup, which scent the following bees then sought, thus being led to the only dish which contained syrup with this scent, the one due north of the hive.

This, then, is part of the language of the bees, a language of dances, which were first described by Prof. K. von Frisch about the year 1923.

Von Frisch described two dances in 1923, a round-dance and a wag-tail dance. He suggested that by means of the round-dance coupled with the perfume of the species of flower from which she has collected the nectar, the dancing bee is able to pass on to other bees information regarding the presence and source of a supply of nectar; and that by means of the wag-tail dance similar information about a source of pollen is given. He did not consider that the dancer was able to indicate the direction in which such a source of food lay or its distance from the hive. Further epoch-making work published by von Frisch in 1946 has shown, however, that it was, as O. W. Park and other observers had thought, incorrect to identify the round-dance exclusively with nectar collection and the wag-tail dance with pollen collection. He stated in 1946 that if the food, whether it be nectar or pollen, is located at the distance of less than about one hundred yards from the hive, a round-dance is performed; if it is situated at a distance greater than one hundred yards, a wag-tail dance takes place. By means of the wag-tail dance a successful forager is able to indicate not only that she has found food at a greater distance than the one hundred yards from her hive and, of course, the perfume associated with that nectar, but is also able, apparently, to give to her sister bees an extraordinarily exact indication of this distance. The distance of the source of food from the hive is indicated by the number of turns, figures-of-eight, in the wag-tail dance that are made in a given period of time. Thus, for example, if the source of food is approximately three hundred yards away, the dancer makes about twenty-eight turns per minute, whereas if it is three thousand yards away she makes only nine turns in the same period of time. The length of the straight run which is interposed between the two loops of the figure-of-eight, and the rate of tail-wagging, increase slightly with increasing distance. Von Frisch does not appear to believe, however, that distance is indicated when the food source is less than about one hundred yards from the hive.

Von Frisch has also shown that the honey-bee is able to indicate the direction in which a feeding place lies, provided that such a feeding place is more than one hundred yards from the hive, by the direction in which she makes the straight run of the figure-of-eight, wag-tail, dance. If the run is made vertically upwards on the comb, this indicates that the feeding place is situated in the same direction as that from which the sun is shining at the time; conversely, if the run is made downwards, the source of food is to be found in the opposite direction to that from which the sun is shining. If the bee runs to the left at a certain angle to the vertical the food can be found at the same angle to an imaginary line drawn between the sun and the hive; and so on. Actually it has been found that the sun can be obscured by cloud without interfering with this direction-indicating mechanism.

It has been found that those bees which become interested in the dance of a returned forager follow her round and thus, presumably, learn the message which her dance conveys.

Now let us consider how a foraging bee, possessing these and many other complicated behaviour patterns, behaves in the field when she is working a more or less homogeneous crop of flowers for nectar. In order to simplify the study, my colleagues and I laid out an experimental field with artificial flowers. Each of these 'flowers' consisted of a Petri dish with a one-pound glass honey-jar full of sugar syrup inverted in it, a small piece of blue porcelain being placed on top of this reservoir to add a little colour. These 'flowers' were regularly arranged at twenty-yard intervals along the arcs of circles, each arc being twenty yards from the arcs on either side of it. The whole experimental area occupied part of a sector, of about 30°, of a circle the centre of which lay near the middle of a fairly large experimental apiary. Each 'flower' was supplied with syrup continuously, and once a number of bees were visiting them regularly the experiments were commenced. One fine day in June 1942, two bees were found to be visiting a 'flower' situated at a distance of about 360 yards from their hives. These two bees were marked so that they could be identified from one another and from all other bees. Continuous observation was maintained at this 'flower', and it was found that these two bees flew between their hive and this 'flower', collecting the syrup and carrying it home with great regularity. In the evening these same two bees were still visiting the 'flower' and had by this time made about a hundred and fifty return journeys in the day; they continued to visit this same 'flower' on subsequent days and never appeared to visit any other despite the fact that they had to fly over or near to a number of similar 'flowers' containing syrup of equal concentration. The same thing was found to be true of other bees visiting various 'flowers' in the experimental field. It therefore appears that so long as there is an abundance of syrup, or nectar, at a given source, bees will confine their attention to this one source for many hours and even for many days.

If we now proceed from this study of the territorial constancy of one or two bees to that of a small, but nevertheless much larger, population, we find that the same thing holds true. It must be pointed out, however, that although this behaviour is in principle probably the same as that which occurs when bees are visiting a natural crop of flowers for nectar or pollen, the time relationships are not of the same order on a flowering crop as on the dishes, since on flowers the time spent by a bee in collecting a load of food is usually much greater than the time spent by this bee in flying to and from her hive.

A number of observations have, of course, been made on natural crops of flowers such as willow-herb (*Epilobium angustifolium*), sainfoin, white clover, etc.; and it was found that bees do exhibit a remarkable degree of constancy to small patches of selected flowers growing in a large group of flowers of the same species. It appears to be reasonable to conclude from a study of the data obtained in these experiments that the honey-bee does not as a rule wander at random over a crop of flowers, but confines her attention to a small area of any crop, the size of this foraging area depending upon the conditions at the time. For example, if the flowers are scattered, then the foraging area of an individual honey-bee is likely to be much greater in extent than would be the case if the flowers were growing close together. The abundance of the nectar or pollen in the flowers also has a profound effect upon the size of the foraging area of each individual. C. R. Ribbands has shown, for example, that in some instances a single flower may for the time being serve as the foraging area of one or more bees. Of course, the foraging areas of individual bees overlap considerably, and if the population of foragers, and therefore the degree of competition, are sufficiently great, there is a further population of wandering bees superimposed upon this relatively fixed population. There is also, without doubt, a third population which is composed of scout bees which leave their hives without any preconceived ideas about what kinds of flowers they are going to work. Having tried a number of different kinds of flowers experimentally, they probably settle down in foraging areas on that crop which is yielding the richest and most abundant nectar or pollen.

It is now fairly clear that the fixation of an individual bee to any particular area of a crop of flowers of one species, and even to one species of flower, is not rigid, although it certainly appears to be the general rule. If, for example, bees are offered a choice between dilute and concentrated sugar syrup in two sets of dishes that have been placed at random in a given area, they will, unless the degree of competition is too great, congregate on those dishes which contain the syrup of the higher concentration. The same thing has been found to occur when syrup of a given strength and nectar are in competition with one another. Thus in some of his experiments Von Frisch found that it was difficult to induce his experimental bees to remain faithful to the dishes of syrup which they had been trained to visit, because flowers in the district contained nectar with a higher sugar content than that of the syrup in his dishes. Ribbands has also demonstrated that individual bees collecting nectar and pollen in a specially planted garden sometimes leave the species of flower from which they have been gathering food for some time and sample the pollen or nectar in a flower or two of another species. It would appear that should this new source of food prove to be more satisfactory than the previous one, they will often desert their old source and establish themselves in foraging areas on the new; but if it proves to be less satisfactory, they soon return to the old source. Even when they have become attached to a new source, they continue to visit a few flowers of the old source from time to time and may return to it once more.

It appears to be reasonably certain, therefore, that honey-bees do not wander over a crop of different species of flowers at random, visiting first one species and then another; but rather that they quickly become attached to one particular species and to a relatively small number of flowers of this species. From time to time, however, they will visit another species experimentally and, should it prove to be a more profitable source of food than that species, or, perhaps, those species, which they have visited hitherto, each bee will select for herself a foraging area in the stand of this new species of flower, and will remain faithful to it just so long as she does not discover an even more profitable source of food elsewhere.

CONCERT HALL ACOUSTICS

THE Acoustics Group of the Physical Society held a meeting on November 4 at the Royal Society of Arts to discuss "Concert Hall Acoustics". The object of the meeting was to bring together musicians, architects, engineers and men of science in a general discussion on concert hall acoustics, with particular reference to the new concert halls for London.

Before describing the discussion, it is important to outline the present state of theoretical knowledge. The most recent major contribution to the theory of acoustics of rooms has been made by P. M. Morse and R. H. Bolt[1]. These authors have analysed the behaviour of sound waves in rooms in terms of wave theory and the appropriate boundary conditions, and obtain exact solutions for rooms of simple shapes, and approximate solutions by perturbation methods for rather more complex shapes. However, the lack of practical knowledge of the acoustic impedance of the materials used internally in concert halls and the complicated shape preclude the direct application of the solutions, and it is necessary to use the simpler concepts of geometrical acoustics. The classical approach of W. C. Sabine[2] in defining the reverberation-time of halls has remained substantially unchanged, and it is Sabine's formula and the minor modifications to it that the architect must use when designing a new hall.

Mr. Hope Bagenal, speaking as an architect, gave a general review of the problem; there is, he said, no consistent London concert-hall tradition. The only contribution was Knightley's Queen's Hall (seating 2,000) in which convex splays were used round the orchestra to reflect the orchestral sound into the auditorium. Knightley also deliberately introduced resonant wood panelling, and this was effective in absorbing low frequencies and enhanced the balance of tone.

Mr. Bagenal described two older building types. The first was the large baroque theatre of the eighteenth century. Low-frequency absorption was good, due to the use of stucco on wood lath; middle- and high-frequencies were absorbed by the upholstery; and the baroque ornament diffused the sound adequately. These factors produced a very short reverberation-time and no echoes, and hence made possible an extreme rapidity of tempo. The other building type was the Leipzig concert hall derived partly from the halls of the Italian musical academies and partly from the early coffee-house rooms. This type was rectangular with a flat ceiling, giving a good distribution of sound. Boxes in the rear wall prevented echoes arising from end reflexion, but there was less absorption per cubic foot of volume than in the theatres. The reverberation-time was longer and consequently the tone was fuller. W. C. Sabine designed the New Boston Concert Hall (1,100 seats) after studying the Leipzig *Gewandhaus* (1,560 seats), and developed his formula for calculation of reverberation-time from these studies.

At this stage in the development of concert halls it had become possible by the development of empirical methods to build a good hall for an orchestra of 80, choir of 220 and audience of 1,500. But in recent years the requirements have changed. The orchestra numbers 120, choir 400 and the audience 3,000 or more. The baroque ornament has disappeared, and it is necessary to introduce elements to fulfil their acoustic functions and yet be in conformity with modern architectural style. Another modern requirement arises from the fact that in parts, at least, modern compositions are much louder than classical works. In Mr. Bagenal's opinion the largest halls are not suitable for the performance of works containing very quiet passages; in the rear seats these passages may even become inaudible. The maximum permissible distance between an orchestra of 120 and the rear seats is 140 ft., for smaller orchestras 120 ft.

Mr. Bagenal then defined the two main requirements for good concert hall acoustics, 'definition' and 'singing tone'. He explained 'definition' as the rapid delivery to the ear of all the pitch components of each note in a note sequence together with their proper order and beat. It also involves the proper hearing of transients. The design requirements to obtain good definition he described as free, direct paths for the sound, reflectors near to the orchestra, and glossy surfaces to reflect the highest frequencies. There is also the negative requirement of absence of echo. 'Singing tone' was defined as a choral character imparted to strings, and produced by reverberation.

In the light of these requirements Mr. Bagenal discussed two types of hall: the older rectangular type with side galleries, and the newer fan-shaped type with wide rear gallery and ramps. The rectangular type would have reflectors at the sides and above the orchestra. The floor seating could rise only slightly, and the orchestra platform would consequently have to be raised with steep platform risers. The definition might suffer from the screening of some players in the orchestra by others, but the random reflexions from the side walls would give good singing tone. The hearing at the back of the hall would be poor because of the long distance. The fan-shaped type would enable the seats to be steeply ramped, and the orchestra could then be placed on the same level as the front seats, providing good definition for all seats. But to prevent echo from the large rear wall, which is often concave, this wall would have to be absorbent, and this might reduce the reverberation and cause poor singing tone. The rear seats would be better than in the rectangular hall owing to the shorter distance. By the use of convex surfaces in the fan-shaped hall the reflexions can be randomized at will.

There is a modified type of hall which combines some of the features of the two types described above. This type is the stepped fan-shape, that is to say, the opening-out of the plan is achieved by a series of steps in the side walls, thus retaining the parallelism of the side walls.

In all types of hall the placing of the organ is difficult, and in a hall suitable for orchestral music the reverberation-time will be too short for good organ tone.

In the discussion that followed, Sir Adrian Boult, speaking as a conductor, stated that, if forced to choose, he would sacrifice definition for a good singing tone; he considered that the latter is essential for the beauty of music. Another conductor, Sir Malcolm Sargent, in a written contribution, obviously had an entirely different definition of singing tone from Mr. Bagenal's definition. Sir Malcolm referred to singing tone as being a function of the harmonics produced by a given instrument independently of its acoustical surroundings. He defined as 'resonance' in a hall the retention of the higher harmonics of the instruments without excessive absorption. Mr. Geoffrey Sharp, who spoke as a music critic, preferred singing tone to definition, on the somewhat opportunist grounds that at the present time the precision of the playing of orchestras is not sufficient to be affected by the acoustics, and that the singing tone reinforces the usually poor quality of strings. Dr. K. Rankl, another conductor, considered that a hall seating 2,500 people is the maximum size for good acoustics. If the public demand is too great to be accommodated in this size of hall, the same concert should be repeated two or three times. He thought that broadcasting acoustics should not be considered, for the requirements are quite different.

Mr. Clive Entwistle put forward, as an architect, a revolutionary plan to seat 6,000 in an annular hall with the orchestra in the centre. He claimed that the main advantage would be that the farthest auditor would be only 108 ft. from the orchestra, compared with 143 ft. for a fan-shaped hall seating 4,000. Mr. P. H. Parkin, speaking as a physicist, pointed out that this proposal assumed that sound is radiated equally in all directions by an orchestra, which is, in fact, not the case for the higher frequencies. Mr. F. Howes also took up this point as a music critic, and said that the 'address' of orchestra to audience would be lost to half the listeners.

Mr. T. Somerville (B.B.C.) described measurements made in two halls, the New Philharmonic at Liverpool and St. Andrew's, Glasgow. In addition to the usual reverberation-time measurements, pulses of sound at specific frequencies with durations of a few milliseconds were injected into the hall, and the resulting variation of sound pressure with time presented on a cathode-ray tube. In the Liverpool hall the build-up and decay of the sound pressure was uneven, whereas in the Glasgow hall the received pulses were sharply defined. This pulse technique was also described by Mr. J. Moir (British Thomson-Houston Co., Ltd.), who showed pulse records taken in a cinema. Mr. Moir claimed that this technique is the most useful for investigating hall acoustics, but stated that quantitative interpretation of the results is not yet possible.

Mr. Parkin (Building Research Station) summarized the results of a questionnaire sent to 175 expert listeners (for example, music critics), in which they were asked for their opinions of the acoustics of ten selected concert halls. The replies showed conclusively that the New Philharmonic Hall, Liverpool, was considered to have very good acoustics. The Royal Opera House, Covent Garden, and St. Andrew's Hall, Glasgow, are two other halls generally considered to be acoustically good. This 'operational research' approach, which bases the assessment of the acoustical properties of a hall on a statistical analysis of critical subjective estimates coupled with physical measurements, was also evident in Mr. W. A. Allen's contribution describing a subjective test made in a concert hall by six listeners. These listeners changed their position in the hall between items in a concert, and there was substantial agreement on the acoustic conditions at the various positions. Mr. Parkin also pointed out that since calculation gave only a rough guide when designing a hall, it would be advantageous to adjust the acoustics of a new hall while building, on the basis of measurements made when the hall was nearly finished.

Mr. R. Howarth (B.B.C.) stated that in a war-time B.B.C. studio the broadcasting acoustics were much improved by the replacement of the wooden orchestral platform by a solid structure.

Mr. H. L. Kirke (chairman of the Acoustics Group), in his summing-up, emphasized the value of meetings such as this in bringing together architects, musicians and men of science. It was obvious that exact definitions of the terms used are required, and that further and more detailed collaboration is necessary.

P. H. PARKIN

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[1] Morse, P. M., and Bolt, R. H., "Sound Waves in Rooms", *Rev. Mod. Physics*, 16, No. 2 (1944).

[2] Sabine, W. C., "Collected Papers on Acoustics" (Oxford University Press).

OBITUARIES

Dr. James Chumley

ON December 12, 1948, there passed away at his home near Edinburgh at the advanced age of eighty-six, Dr. James Chumley, thus bringing to an end a long life of service to biological science the more worthy of commemoration in *Nature* in view of the fact that most of his work was carried on unseen and unrecorded by publication under his own name.

In the closing years of the nineteenth and early years of the present century, one of the chief centres of zoological activity was the "Challenger" Office, Edinburgh, where John Murray supervised the working out of the immense collections brought home by H.M.S. *Challenger*. From a subordinate position in the office, Chumley rose to become Murray's secretary and right-hand man in the work of caring for the collections, distributing them for investigation by specialists and eventually editing the fifty volumes of "Challenger Reports" which may well be regarded as forming the foundations of the modern science of oceanography. Chumley claimed, no doubt justifiably, to be the only man in existence who had read every word of these reports.

In addition to his work in the "Challenger" Office, Chumley acted as secretary and treasurer of the Scottish Marine Station at Granton, built with funds subscribed by friends of John Murray, by the margin of a great quarry which had been invaded by the sea and converted into an immense natural aquarium. Attached to the Station were a large lighter with deckhouse laboratory moored in the middle of the quarry and humorously designated the *Ark*, and a small research ship of 30 tons, the *Medusa*. The Granton Marine Station served to introduce various zoologists, including the present writer, to the science of marine biology, and incidentally it may be regarded as the ancestor of the important Millport Marine Station of to-day, for the *Ark* and the *Medusa* were taken through the Forth–Clyde Canal in 1884 and utilized in the Clyde area for investigations supplementary to those of the *Challenger*. After the conclusion of this work in 1892, the *Ark* remained at Millport; it was drawn up on the shore and continued to function as a laboratory until destroyed by a storm in December 1900, an extension having already been provided which still exists as part of the present Station.

Murray's plans to return to the Clyde and take over the Millport Station were brought to nought by his sudden death by accident in 1914. The *Challenger* collections were handed over to the British Museum (Natural History), and Chumley was appointed a teaching fellow in the Department of Zoology, and later as lecturer on oceanography, in the University of Glasgow. There he continued to play the same active unobtrusive part as he had in the "Challenger" Office. The arrangement and cataloguing of the large library and the card catalogues of local fauna were in the main the work of James Chumley; and those in the Department of Zoology who published work during his twenty years in Glasgow owe him an inestimable debt for his ever-ready assistance in matters of bibliography and editorial revision.

As already indicated, Murray carried out, as an extension of the *Challenger* work, oceanographical researches in the Clyde sea area. So far as concerns physical oceanography, the results of these investigations were duly worked up by one of Murray's colleagues, H. R. Mill; but the zoological results had remained untouched. This blank Chumley proceeded to fill, and his first two years in Glasgow were devoted to working through the *Medusa* records with the idea of thereby laying a foundation for subsequent faunistic work. The result was his valuable "Fauna of the Clyde Sea Area", published by the Glasgow University Press in 1918.

JOHN GRAHAM KERR

Prof. W. J. Dann

PROF. WILLIAM JOHN DANN, professor of nutrition at the Duke University School of Medicine, Durham, North Carolina, died at his home on December 5. Prof. Dann was born in Bath, England, on November 9, 1904, and graduated at the University of Sheffield in 1925. Later he went to Cambridge, where he received the Ph.D. degree in 1932, after working under the direction of Sir Frederick Gowland Hopkins.

Dr. Dann, who had been at Duke University since 1935, became a recognized authority in the field of nutrition and the study of vitamins. He was a Beit

Memorial Fellow at the University of Cambridge between 1933 and 1937, and was awarded the degree of D.Sc. by the University of Sheffield in 1943.

For many years Prof. Dann served as an editor of the *Journal of Nutrition and Nutrition Reviews*, and as a member of the Institute of Nutrition. He was co-author of the book "The Determination of the Vitamins". At Duke University he did outstanding work and research on pellagra and other deficiency diseases, and the use of nicotinic acid in combating them. His death at the early age of forty-four involves a great loss to the University and to science.

WE regret to announce the following deaths:

Prof. L. Farkas, professor of physical chemistry in the Hebrew University, Jerusalem, on December 31.

Prof. Hermann J. Levy, formerly of the Technical College, Berlin, an authority on the economics of industrial assurance and of retail distribution, on January 16, aged sixty-seven.

Dr. J. Gilbart Smyly, formerly regius professor of Greek in Trinity College, Dublin, known for his work on the Tebtunis and the Flinders Petrie papyri, on December 25, aged eighty-one.

NEWS and VIEWS

Girton College, Cambridge: Dr. Mary Cartwright, F.R.S.

MISS MARY LUCY CARTWRIGHT, whose appointment as Mistress of Girton has been announced, is recognized as one of the leading pure mathematicians in Great Britain. A pupil of G. H. Hardy at Oxford, she gained the degree of D.Phil. at that University, but migrated to Cambridge in 1930, on her election to a fellowship at Girton. Her early work was on Abel summability and Dirichlet series. This was followed by a long series of papers on integral functions and functions regular in angle. Influenced possibly by J. E. Littlewood, she then turned her attention to inequalities for *schlicht* and related functions, and in 1935 made what is perhaps her most striking discovery, the inequality

$$|w(z)| < A(p)\,\mu\,(1-r)^{-2p}$$

for a function which takes no value more than p times in the unit circle. During the War, Miss Cartwright worked in an entirely different field, the theory of non-linear differential equations. The great practical importance of this field has long been recognized; but the mathematical difficulties are very formidable. The subject has advanced greatly as a result of the war-time work of Miss Cartwright, Prof. Littlewood and others. Miss Cartwright was elected a fellow of the Royal Society in 1947, the first woman mathematician to be so honoured.

Zoology at Sydney: Dr. P. D. F. Murray

DR. P. D. F. MURRAY has been appointed to the chair of zoology at the University of Sydney. Dr. Murray, who is a graduate of Sydney, first came to England as a research student to study under Dr. Julian Huxley at Oxford. He then returned to Sydney, where he held a lectureship in the Zoology Department. In 1930, having obtained a Rockefeller travelling fellowship, he returned to England to work at the Strangeways Research Laboratory, Cambridge, and in the same year was awarded the Smithson Fellowship of the Royal Society. He left Cambridge in 1937 to take a teaching post at Bedford College, London, and in 1939 he was appointed to a university readership in biology at St. Bartholomew's Hospital Medical College. Dr. Murray is well known for his studies on the developmental mechanics of the skeleton in embryonic life. In these investigations the potentialities of the mesoderm of the early chick limb-bud were analysed by isolating different regions of the rudiment and studying their development when grafted on the chorio-allantoic membranes of the egg. Dr. Murray also made an extensive series of experiments on the physiology of the heart rudiment, using the tissue-culture technique and observing the effect of various ions on the character of the beat. Recently he has returned to his researches on the problems of skeletogenesis.

Institution of Electrical Engineers: Capt. J. M. Donaldson, M.C.

CAPT. J. M. DONALDSON has been elected an honorary member of the Institution of Electrical Engineers in recognition of his distinguished contributions to electrical power engineering, particularly in the fields of generation, transmission and distribution; and for his services to the Institution. Capt. Donaldson was educated at Whitgift Grammar School, Croydon, and at Finsbury Technical and Central Technical Colleges. His first appointment, in 1897, was with the British Thomson-Houston Co., London, and he then studied American methods for four years in the United States and Canada. In 1906, he was appointed general assistant engineer to the North-Metropolitan Electric Power Supply Co., becoming a director of the Company in 1943. Under Capt. Donaldson's technical guidance the 'Northmet' system grew to be one of the largest co-ordinated electric power supply networks in Great Britain. He carried out much pioneer work in the field of supply, particularly in the use of steam at increased pressures and temperatures in the generating plants for which he was responsible. He now serves as a member of the Eastern Electricity Board. Capt. Donaldson was president of the Institution of Electrical Engineers in 1931, and has served as a member of a number of committees of the Council.

Mr. C. S. Franklin

THE twenty-seventh award of the Faraday Medal has been made to Mr. Charles Samuel Franklin for his distinguished work in radio engineering, and in particular for his original studies of short-wave wireless transmitting and receiving circuits and his invention of the beam aerial, by means of which the practical use of short-wave transmission for communication purposes was established. Mr. Franklin was born in 1879 and received his engineering and scientific training at Finsbury Technical College under Prof. Silvanus Thompson. In 1899 he joined Marconi's Wireless Telegraph Co., then known as the Wireless Telegraph and Signal Co., and was continuously associated with research and development in radio engineering with that Company until 1935, when he retired from active work. During his period with the Company, many outstanding developments stood to his credit, including reaction patents for wireless receiver circuits, the early British broadcasting stations, directional receiving systems for long-wave communication circuits, rotating beam aerials, short-wave wireless transmitting and receiving circuits, and in particular the beam aerial array associated with his name, which was the fundamental invention comprised in the beam system of wireless telegraphy. He also developed the concentric cable system, which is essential in television transmission practice. Mr. Franklin was the first recipient of the James Alfred Ewing Medal, instituted in 1936 in memory of Sir Alfred Ewing and awarded by the Institution of Civil Engineers for specially meritorious contributions to the science of engineering in the field of research.

American Association for the Advancement of Science: New President

PROF. ROGER ADAMS, head of the Department of Chemistry in the University of Illinois, has been appointed president-elect of the American Association for the Advancement of Science, and will serve as president during 1950. A former president of the American Chemical Society, Prof. Adams has received many honours for his work as a teacher and his research achievements in synthetic organic chemistry, including the Davy Medal of the Royal Society in 1945 (see *Nature*, **156**, 695; 1945). The president of the Association for 1949 is Prof. Elvin C. Stakman, professor of plant pathology in the University of Minnesota. The next meeting of the Association will be held in New York during Christmas week.

T. L. Beddoes (1803–49)

THOMAS LOVELL BEDDOES, who died by his own hand a century ago, on January 26, 1849, is an intriguing example of a medical man in whom—to use Sir Arthur MacNalty's striking phrase—the twin heritages of Apollo (medicine and poetry) were always striving for the mastery. Eldest son of the eccentric Bristol physician, Thomas Beddoes, and nephew of the novelist Maria Edgeworth, he was born at Clifton on July 20, 1803. Educated at Bath Grammar School, at Charterhouse, and at Pembroke College, Oxford, he published "The Improvisatore" while an undergraduate; but it was "The Bride's Tragedy" that won the praise of the critics in 1822. Abandoning literature for medicine, he went to Göttingen three years later, and as a medical student sat at the feet of Blumenbach, Langenbeck, and Stromeyer. After graduating M.D. at Würzburg in 1832, he practised in Germany and in Zurich. For a time he was engrossed in experimental physiology, and he translated R. D. Grainger's "Observations on . . . the Spinal Cord" into German; his translation apparently was never published. Towards the end of his life his mind became clouded, and there is some evidence to suggest that he inflicted a wound on his left leg, which became gangrenous and had to be amputated. While in hospital at Basle, he took his own life with curare, though apoplexy was recorded as the official cause of death. His macabre play, "Death's Jest-Book", was published in the following year. Despite its extravagant and unbalanced moods, Beddoes' poetry shows true lyrical greatness.

National Institute of Agricultural Engineering

THE Agricultural Machinery Development Board, which has been responsible during the past seven years for advising on research and development work on agricultural mechanization and on the management of the National Institute of Agricultural Engineering, is now being replaced by a new and independent governing body of the National Institute of Agricultural Engineering. This body will be constituted legally as a company limited by guarantee and without share capital, and will receive grant aid from the Ministry of Agriculture and the Department of Agriculture for Scotland. The headquarters station of the old Institute at Wrest Park and its Scottish station at Howden will be continued under the new organisation. The members of the governing body, consisting of a chairman and twelve members, have been appointed jointly by the two Agricultural Ministers with the advice of the Agricultural Research Council. Communications should be addressed to the Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, Regent's Park, London, N.W.1.

In accordance with a recommendation of the Agricultural Machinery Development Board, the Minister of Agriculture and the Secretary of State for Scotland have appointed an Agricultural Machinery Advisory Committee, which will be a permanent body and will consist of representatives of the agricultural and agricultural engineering industries and of the interested Government Departments. Communications should be sent to Col. C. K. Hamilton, Ministry of Agriculture and Fisheries, 14–21 Chester Terrace, Regent's Park, London, N.W.1.

The National Central Library

THE thirty-second annual report of the executive committee of the National Central Library, covering the year ending February 29, 1948, again refers to a considerable increase in the services of the Library to all the categories of libraries with which it is in co-operation. Issues from or through the Library during the year reached 84,889, an increase of 28·6 per cent on the previous year; of these, 8,655 were to university libraries, as against 6,073 in 1946–47, and 7,823 to the libraries of Government departments, research and industrial organisations, etc. Issues from the Scottish Central Library for Students increased from 13,690 to 15,547, and from the Irish Central Library for Students from 12,893 to 13,082. Twelve further special libraries have been added to the group of "Outlier Libraries", which now numbers 189, and 15,023 books were lent by these libraries during the year, as against 11,289 in the previous year. There are now 589 libraries co-operating in the regional systems and in the London borough libraries interlending system, and 142,832 books were lent by these libraries to other libraries in their own system during the year, as against 120,992 in 1946–47. Loans to foreign libraries during the year increased to 325, and 82 books were borrowed by British libraries from foreign sources. The Bureau of American Bibliography continues to demonstrate its value as the main source of information about American books and periodicals, and 123,270 further entries were made during the year in the main catalogues of the National Central Library, in Wales and in Scotland. Steady progress is now being made with the Union Catalogue of Russian Books and Periodicals, and the Library has also added to its activities that of a National Book Centre to coordinate the interchange and distribution of otherwise 'unwanted' publications. The report stresses the serious position caused by the continued shortage in book production, and records some increase in staff and a start on preventive repairs on the devastated portion of the building at Malet Place, London.

Spiritual Approach to Physics

UNDER the title "The Value of the Individual", Mr. F. I. G. Rawlins, in Occasional Paper No. 5 of the British Social Hygiene Council, asks physicists to look beyond their immediate pre-occupations. Physical science, he argues, arrives at a point where it can go no further; but this does not justify the assumption that there is nowhere further to go. Modern physical theory cannot (with Laplace) postulate a universe which is a self-maintaining system, about the origins or destiny of which it is superfluous to inquire. The step from physics to theology is not compulsory; but there is nothing to prevent it and a good deal to encourage it. Only when that step is taken can the universe be seen as an environment with a meaning, where human personality is able to realize itself.

Anatomy and Physiology of Acrididæ

UNDER the title of "Recent Advances in Acridology", Dr. B. P. Uvarov contributes a general survey of the literature on the anatomy and physiology of locusts and grasshoppers. It covers the period that has elapsed since the publication of the same author's book, "Locusts and Grasshoppers", in 1928. During the interval of twenty years the titles of nearly 2,500 papers, published in twelve languages, have been added to the bibliography that is kept up to date at the Anti-Locust Research Centre in London. The present survey is intended to provide a digest of all publications bearing upon anatomy and physiology. Other surveys dealing in particular with development, ecology, control, etc., will follow. The object of these digests is to further research and investigation by making the relevant literature more easily found. Particular attention has been paid to collating widely scattered data and papers that are not readily accessible. The present survey appeared, under the title given above, in the *Transactions of the Royal Entomological Society of London*, vol. 99, Part 1, pp. 1–75, 1948, and has been reprinted as "Anti-Locust Bulletin No. 1" by the Anti-Locust Research Centre, British Museum (Natural History), London, S.W.7. It is to be obtained in exchange from the Anti-Locust Centre, or may be purchased from the Royal Entomological Society, 41 Queen's Gate, London, S.W.7 (price £1 4*s*.).

Physical Society : Meeting at Edinburgh

A ONE-DAY meeting of the Physical Society will be held on February 19 at the University of Edinburgh, in the Department of Natural Philosophy. The morning session will include three papers on developments in electron focusing : T. H. Braid and H. O. W. Richardson will describe tests of a wide-angle β-particle spectrometer; R. E. Siday and D. A. Silverston will discuss tests of a prism spectrograph ; and A. N. Barker, Prof. N. Feather and H. O. W. Richardson will describe an emission microscope for photo-electron autoradiography. A paper on the use of proportional counters to investigate β-disintegration will be given by S. C. Curran, and a paper on electrons as nuclear projectiles by B. Touschek. In the afternoon session, subjects to be discussed are : a new approach to the theory of elementary particles, by Prof. M. Born and H. S. Green ; film transport in liquid helium II, by Prof. J. F. Allen ; a new photo-electric amplifier, by R. V. Jones ; and long-range molecular forces, by J. Iball.

Announcements

SIR HAROLD SPENCER JONES, Astronomer Royal, has been awarded the Catherine Wolfe Bruce Gold Medal for 1949 of the Astronomical Society of the Pacific, for distinguished services to astronomy.

PROF. P. M. S. BLACKETT, Langworthy professor of physics in the University of Manchester, has been awarded the Dalton Medal of the Manchester Literary and Philosophical Society, in recognition of his outstanding contributions to the advancement of our knowledge of physics. This Medal has been awarded on six previous occasions, as follows: Edward Schunck (1898), Sir Henry Roscoe (1900), Prof. Osborne Reynolds (1913), Sir Ernest (Lord) Rutherford (1919), Sir J. J. Thomson (1931), Sir Lawrence Bragg (1942). The presentation will take place at a conversazione with which the Society will open the new session in October 1949.

THE first award of the "Medal for Service in Agriculture and Forestry" of the Institute for International Relations in Agriculture and Forestry in Prague has been made to Prof. Doncho Kostoff, director of the Institute for Applied Biology and Organic Development at the Academy of Sciences, Sofia, and professor of plant breeding and evolution in the Faculty of Agronomy, for his monograph, "Cytogenetics of the Genus *Nicotiana* (1941/1943)", on the ground that it is the most noteworthy book in the Slavonic languages published during the last few years.

MR. J. W. TULLO has retired from the post of chief chemist to Messrs. Arthur Guinness, Son and Co., Ltd., Dublin, with whom he has been associated for the past fifty years. He has been succeeded by Mr. J. Andrews.

DR. F. A. FOX, deputy director of the British Welding Research Association, has been appointed deputy technical manager of Messrs. H. J. Enthoven and Sons, Ltd., London, E.C.3.

THE Fifty-fifth Conference of the Deutsche Gesellschaft für innere Medizin is due to take place in Wiesbaden during April 25–28, 1949. The chief themes for discussion will be: protein exchange; chemotherapy; circulation problems; and psychosomatic medicine and neuritis.

A COURSE of six lectures on "Electronics in Industry" will be given at the Electrical Engineering Department of The Polytechnic, 309 Regent Street, London, W.1, by Mr. L. I. Farran. The lectures will be given on Fridays at 6.30 p.m., commencing February 4, 1949, and the fee for the course is 10*s*.

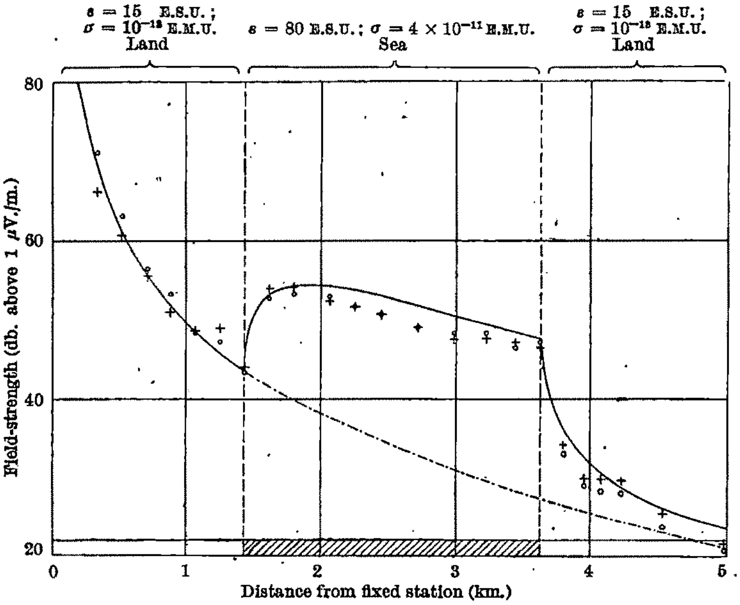
THE University of Oxford has accepted the generous gift from the American Cyanamid Company, Stamford, Connecticut, of a Perkin Elmer infra-red spectrometer with recorder and accessories. This has been installed in the Physical Chemistry Laboratory under the supervision of Dr. H. W. Thompson, and will be used for spectroscopic investigations of a fundamental character, and particularly with regard to problems of biochemical importance. In the latter connexion it is hoped to undertake co-operative work between several of the University laboratories at Oxford.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Ground-Wave Propagation Across a Land/Sea Boundary

In a paper to be published shortly[1], I have discussed the problem of ground-wave transmission across a land/sea boundary, and have predicted that under some conditions there should be a marked recovery in field-strength. On medium wave-lengths this recovery should extend to a considerable distance over sea, though, so far as I am aware, no conclusive evidence of this phenomenon has yet been published. The theory shows that the effect should not be confined to the diffraction region; but that on sufficiently short wave-lengths it should occur at distances where the Sommerfeld flat-earth analysis is valid.



———, Theoretical curve, land and sea; —·—·—, theoretical curve, land only; +, measurements at fixed station; o, measurements at mobile station. $\lambda = 3 \cdot 9$ m.; $P = 10$ watts; vertical polarization, $h_T = h_R = 0$

For vertical polarization on a wave-length of 4 metres, the recovery should be well developed when the land/sea boundary is only a kilometre from the transmitter, and the maximum increase in field-strength when both aerials are on the ground should then be of the order of 12 db. and occur at about 0·5 km. beyond the boundary. Experimentally, these conditions are favourable for the finding of a suitable site free from irregularities of terrain comparable with the wave-length, and for obtaining adequate field-strengths at the required distances with a portable transmitter. The expected increase is also greatly in excess of any likely instrumental or site errors.

Fortunately the Marconi crystal-controlled transmitter-receiver *H*.16 working on 77·575 Mc./s. (λ ≈ 3·9 m.) is ideally suited for the purpose, giving a radiation of 10 watts from a vertical half-wave dipole and permitting two-way transmission and reception with telephonic communication. An experiment has been carried out using one such set as a fixed station on the Mundon Marshes south of the Blackwater, Essex, while another was moved from it along a straight line to the shore 1·4 km. away, and then across the sea path of 2·2 km. in a motor-boat. Field-strength readings were taken at high tide at each station at intervals along the land- and sea-paths, and at a number of points on the land on the farther side.

The results are shown in the accompanying graph. On this wave-length the propagation over land is controlled mainly by the permittivity, and a value of 15 E.S.U. deduced from the shape of the initial land curve has been taken in computing the theoretical curve. The assumption that the propagation is unmodified before a boundary is effectively fulfilled, and the test confirms the prediction as regards both the extent and the position of the recovery. It also affords an interesting check of the reciprocity condition over such a composite path.

The measurements over sea were conditioned by the necessity of stopping the engine of the boat while taking a reading and the consequent drift off course. The low values may be accounted for by obstructions on the modified land path, in particular a section of sea wall lying along the path. To overcome this difficulty, a continuous recording was made at the fixed station of the signal from the mobile transmitter while the boat kept on its course at uniform speed, and the curve so obtained agrees closely with the theoretical curve over the whole of the sea path, including the initial rapid rise of field-strength.

The terrain on the farther side was less favourable for unobstructed transmission, involving the choosing of measuring sites considerably off course; but the values confirm the correspondingly rapid drop in field-strength that occurs on crossing a sea/land boundary. On this wave-length the theoretical curve would eventually settle down to the all overland curve if the sea section were somewhat farther from the transmitter.

The theory is admittedly approximate, but this confirmation at a short wave-length strongly supports the explanation I have given of these effects in terms of a redistribution of energy above the ground, whereby the height-gain relation on one side of the boundary changes to that characteristic of the section on the other side, and strengthens one's confidence in the use of the theory on medium and long waves, where the results can be of profound practical importance.

G. Millington

Research Division,
Marconi's Wireless Telegraph Co., Ltd.,
Great Baddow,
Essex.
Dec. 7.

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[1] *J. Inst. Elect. Eng.* (in the press).

Tolerance Flux of Thermal Neutrons

THE danger of neutrons on the human body arises from two factors: the slowing down of fast neutrons and the absorption of neutrons. In the case of thermal neutrons, only absorption can take place, either in hydrogen to form a deuteron with emission of a 2·2-MeV. γ-ray, or by nitrogen-14 to form a carbon, with the emission of a 0·7-MeV. proton. In a very complete paper on the subject, Mitchell[1] finds that the ionization produced in the human body can be attributed half to the γ-rays of the latter reaction and half to the protons. This note deals only with the γ-rays from the $H(n,\gamma)D$ reaction.

Mitchell starts from the idea that the distribution of neutrons in the body is given by an exponential function, and he works out the ionization produced at the surface by γ-rays liberated in the semi-infinite medium. With a diffusion length of 2·8 cm. he finds that the maximal dose is attained with an incident flux of thermal neutrons of the order of 1,000–2,000 neutrons/cm.^{2}/sec.

It is well known that the ordinary theory of diffusion of thermal neutrons cannot be applied near a discontinuity (the surface of the body in this case), and as we expected that a purely exponential function would be invalid and could vitiate the result quite a lot, we have set up an experiment to determine the true distribution function with a thermal neutron source outside a paraffin block. This source was a 2,400-mc. radium–beryllium source in a howitzer from which neutrons are 'focused' on to a paraffin block 50 cm. away. The detectors were rhodium plates 0·05 gm./cm.^{2} irradiated for five minutes, the activities of which were measured on both sides of the detector. Those detectors were irradiated at different depths inside and outside the paraffin and in such conditions that the contribution from the different kinds of neutrons could be determined. The results are shown in Fig. 1. Curve *A* gives the total activity of the rhodium; curve *B* gives the activity when a large cadmium screen completely shielded the paraffin block; this activity being due, therefore, to the resonance neutrons and the thermal neutron by-products of the resonance slowed down to thermal energies. Curve *C*, with the rhodium plates completely shielded in a cadmium envelope, gives the distribution of resonance neutrons. Curve *E* (equals *A* – *B*) gives the distribution of thermal neutrons only.

Activities measured at the surface and outside the paraffin cannot be attributed to neutrons travelling in the direction howitzer–paraffin only, but also to neutrons scattered and diffusing back in the direction paraffin–howitzer. It can be calculated that, in our experimental arrangement, 65 per cent of outside and surface activities comes from neutrons travelling in the direction howitzer–paraffin. The neutron distribution function is then given by:

$$N = N_0 \{2{\cdot}55 \exp(-x/L) - \exp(-x/l)\},$$

for an incident flux of N_0 neutrons/cm.^{2}/sec., and with $L = 2{\cdot}1$ cm. and $l = 0{\cdot}38$ cm., equal to the thermal neutron data as given by Fermi[2].

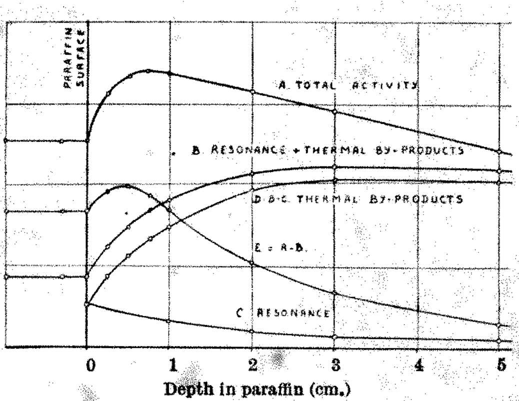

Fig. 1

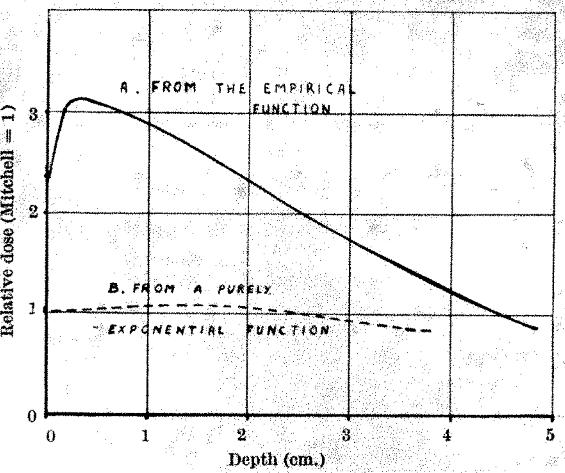

Fig. 2

This result is the outcome of, on one hand, an inside diffusion of neutrons, and, on the other, near the surface there is a leakage up to a distance which is of the order of the mean free path.

We have worked out the ionization arising from such a function at the surface as well as in depth, and extended Mitchell's calculations in depth for a purely exponential function (full details will be published elsewhere); the results are as follow:

(1) For a given incident neutron flux the surface dose is double that worked out by Mitchell (Fig. 2).

(2) The ionization dose passes through a maximum at 0·3 cm. with an intensity three times Mitchell's value.

To keep within the limits of the maximum tolerable dose, and taking into account the contribution of the $N(n,p)C$ reaction, we suggest that the maximum flux of incident neutrons should be limited to about 500 neutrons/cm.^{2}/sec.

P. CAPRON
M. FAES
G. C. TAVERNIER
Institut Interuniversitaire de Physique Nucléaire,
Centre de Louvain.
Nov. 21.

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[1] Mitchell, *Brit. J. Rad.* (Feb. 1947).

[2] Fermi and Amaldi, *Phys. Rev.*, **50**, 899 (1936).

Method of Steepest Descents in X-Ray Analysis

IN the method of steepest descents, atomic co-ordinates are derived by minimizing a function of the observed and calculated structure amplitudes. Hughes[1] minimizes $\Sigma w\,(F_0 - F_c)^2$, where the weighting factors are $w \sim 1/F_0{}^2$ when $F_0 > 4\ F_t$, and $w \sim 1/16\ F_t{}^2$ when $F_0 < 4\ F_t$; F_t is the threshold value of the measurement. As the errors do not obey Gauss' law, this formula does not give the best least-squares solution.

It was shown by Vand[2] that the formula

$$R_2 = \Sigma (F_0^2 - F_c^2)^2,$$

which is minimized by Booth[3] by the method of steepest descents, is applicable only when all the observations of the intensities of the X-ray reflexions have equal weight. A logarithmic formula

$$R_3 = \Sigma (\log I_0 - \log I_c)^2$$

was then recommended for a case where all the signs of F are known.

It can be shown both experimentally and theoretically that when the assumed co-ordinates of a structure differ greatly from the true co-ordinates, as is the rule in the initial stages of approximation, the errors $F_0 - F_c$ increase proportionately with increasing Miller indices. This effect should be taken into account when assessing their weight. When the effect of the observational errors of the intensities on weight can be neglected, a function

$$R_4 = \Sigma \frac{(F_0 - F_c)^2}{(h^2 + k^2 + l^2)}$$

should then be minimized. It is possible to derive more general formulæ which take into account the effect on weight of both Miller indices and of experimental errors simultaneously. They deserve closer study but seem to be too cumbersome for practical application. At the initial stages, R_4 should thus be preferred, until a stage is reached when no more changes of signs of F are expected, or when the discrepancies are due to experimental error in F_0 rather than to incorrect co-ordinates; then R_3 should be used. Fewer steps are then required than if R_3 were used throughout, as the correct assessment of weights has a great effect on the rapidity of convergence towards correct structure as well as on the accuracy of the final co-ordinates.

V. VAND

Research Department,
Lever Brothers and Unilever, Ltd.,
Port Sunlight, Cheshire.
July 23.

[1] Hughes, E. W., *J. Amer. Chem. Soc.*, **63**, 1737 (1941).
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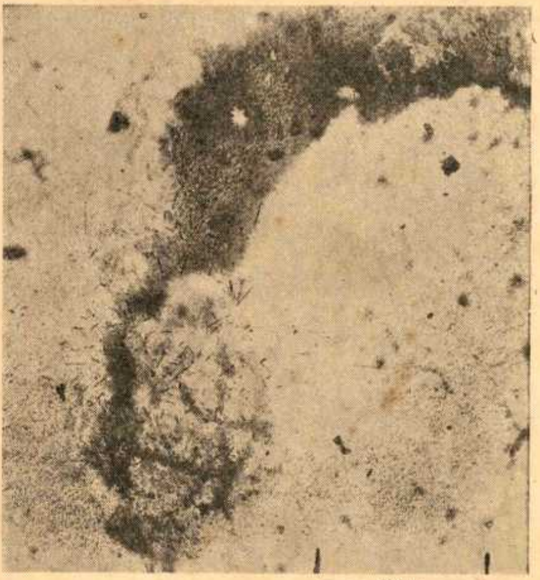
Investigation of the Distribution of the Radioactive Elements in Rocks by the Photographic Method

IN a previous communication in *Nature*[1], a brief account of the use of nuclear plates for the measurement of the total radioactive content of rocks has been given. The results showed that the distribution of the radioactive elements in rocks is not uniform, and that for some rocks quite large concentrations occur.

In order to investigate this effect more fully, a slightly different technique has been adopted. A standard microscope slide of the rock to be examined is made, but the cover glass is omitted, so that the α-rays from the rock can affect a nuclear plate placed in contact with the slide. Both slide and plate are placed in a specially constructed brass frame, in which they are held against three definite contacts, so that either slide or plate can be removed from the frame and replaced in nearly exactly the same position. Microscopic tests showed that this condition is quite accurately fulfilled. It is most convenient first to place the nuclear plate in the frame, film side up, and then put the microscope slide on top with the rock slice down. The desired exposure can then be given and the slide and plate removed for the development of the plate. The frame is now placed on the mechanical stage of a microscope and the plate replaced in it. The distribution of the α-tracks on the plate can now be correlated with the rock minerals, by replacing the rock slide on top of the plate and slightly altering the focus of the microscope. Polarized light can be used for the identification of these minerals in the usual manner. Since the rock slice has to be examined through the glass slide, only a moderate power objective can be used for the purpose. We found a Leitz No. 3*A* suitable.



It may be mentioned that both Mme. A. Hée[2] and E. E. Picciotto[3] have described similar techniques for using rock slides; but neither technique seems to be as convenient.

The first rock to be examined by this method was a Kuru granite from north of Tammerfors (Tampére), Finland. In a total area of about 8 cm.^{2} of rock examined, 45 concentrations of α-tracks were observed. Of these, 33 appeared to be due to small yellowish-brown crystals usually associated with the biotite in the section, two due to small colourless crystals, and in seven cases no obvious source in the rock structure could be detected. The accompanying photomicrograph shows the type of result obtained. The photograph has been obtained by first taking the nuclear plate image alone, then inserting the rock slide in the frame on top of the nuclear plate, refocusing the microscope, and exposing a second plate. The resulting two negatives are then combined by means of double printing, and a new negative made from this positive.

The dark material shown in the photograph is biotite, and the light background a mixture of felspar and quartz. The small yellow crystal can be seen near the lower left-hand corner. It is traversed by dark cracks. Nearly all the α-ray tracks appear to originate from this crystal. It must be remembered that a certain spread in the distribution of the tracks will occur owing to the emulsion not coinciding exactly with the radioactivity source due to the finite thickness of the rock slice and of the air film between the slice and the plate.

The total number of particles in the concentration, as shown on the original negative, is 157. Very few α-rays seem to originate definitely from either the biotite or the quartz and felspar. The nuclear plate was exposed to the rock slice for about ten days.

An attempt to identify the yellow crystals has been made by petrological methods. We would wish to thank Prof. L. B. Smyth and Mr. J. C. Brindley for their assistance in this matter. The crystals are non-pleochroic, isotropic and of high refractive index. The known constituent minerals of Kuru granite are microcline, orthoclase, quartz and biotite, with ilmenite and zircon as accessory minerals[4]. Both Prof. Smyth and Mr. Brindley consider that the crystals are probably melanite; but Brindley suggests perovskite as an alternative.

The absolute radioactivity of the crystal shown may be roughly estimated from the number of α-particles emitted. Assuming that the crystal is tabular in form, and that its thickness is the same as that of the rock slice, and that its radioactivity is due only to uranium in equilibrium with its products, we find that it must contain about 0·3 per cent of uranium by weight to emit the particles observed, if the density of the crystal is about 4 gm./c.c. This would seem to show that the crystal cannot be a pure uranium or thorium mineral. This is confirmed by the fact that about 40 per cent of the yellow crystals show no concentrations.

It may be possible to identify these crystals by further investigation, and work on this problem, and other rocks, is proceeding.

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Nov. 12.

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Co-ordinate Operators in Quantum Mechanics

It has been suggested that co-ordinates should be represented in the quantum theory by operators analogous to those which represent orbital angular momentum[1].

Thus, the co-ordinate x is to be replaced by $a\left(x\frac{\partial}{\partial\eta_0} - \eta_0\frac{\partial}{\partial x}\right)$, where a denotes a length and η_0 an additional co-ordinate. If η_0 be identified with the fifth co-ordinate occurring in the theory of Kaluza and Klein with the limitations, in accordance with the requirements of physics, that $\frac{\partial}{\partial x^5} = 2\pi i m_0 c/h$ and $x^5 = h/m_0 c$, where m_0 is the mass of the particle located, it follows that the x-co-ordinate operator should take the form

$$X = x - \frac{h}{m_0^2 c^2} u_x, \tag{1}$$

where[2]

$$u_x = \left(\frac{\hbar}{i}\frac{\partial}{\partial x} - \frac{e}{c}\varphi_x\right).$$

The various symbols are in common use and need not be explained in detail. The fact that the orbital angular momentum operators do not completely describe the angular momentum of a fundamental particle but require also the expression for the spin suggests that these co-ordinate operators likewise require the addition of an analogous expression. The group of angular momentum and co-ordinate operators can be regarded as forming a single tensor[3]; and from this fact it is suggested that the co-ordinate should be extended so that it takes the form

$$X = x - \frac{h}{m_0^2 c^2} u_x + \frac{i\hbar}{2m_0 c}\beta\alpha_x, \tag{2}$$

where β and α_x denote Dirac matrices.

There are similar expressions for the other co-ordinates and there is a time operator, X_4, with

$$X_4 = x_4 - \frac{h}{m_0^2 c^2} u_4 - \frac{\hbar}{2m_0 c}\beta, \tag{3}$$

where

$$x_4 = ict \text{ and } u_4 = \left(\frac{\hbar}{i}\frac{\partial}{\partial x^4} - \frac{ei}{c}\varphi\right).$$

The second terms on the right in expressions (2) and (3) mean that a minimum proper time of magnitude h/m_0c^2 is to be associated with a particle[2] of rest mass m_0. This shows that a definite extent is to be associated with a moving particle which is, however, small when the velocity of the particle is small in comparison with that of light. The last term of expression (2), like the corresponding term representing the spin, means that an intrinsic property is to be associated with the particle. Neglecting the second term, the proper values of X are $(x \pm \hbar/2m_0c)$. An interpretation of this is that, if the co-ordinate x is chosen in the usual way, the particle is described as being located at

$$(x + \hbar/2m_0c) \text{ or } (x - \hbar/2m_0c)$$

and not at any point within these limits. This indicates that a finite length $\hbar/m_0c$ is to be associated with the particle.

If X is differentiated with respect to time in accordance with the rule of quantum mechanics, it is found that

$$m_0\dot{X} = -\beta u_x - he\,(\vec{E} + \vec{H} \times \vec{\alpha})_x/m_0c^2, \tag{4}$$

where $\vec{E}$ and $\vec{H}$ denote the electric and magnetic field intensities, under the influence of which the particle is in motion. This is an interesting result, because it introduces into quantum mechanics a relation which corresponds to the familiar definition of classical mechanics, namely,

mass × velocity = momentum.

The old form is retained exactly only in the case when there are no forces, but the relation does not occur at all in the usual form of quantum mechanics.

The additional term in (4) shows how the definition is modified when the particle is accelerated, just as expression (2) shows how the co-ordinate is modified when the particle is in motion.

It also follows that, except for a small imaginary term, Dirac's equation becomes

$$\alpha_x\dot{X} + \alpha_y\dot{Y} + \alpha_z\dot{Z} - i\dot{X}_4 = c, \qquad (5)$$

which means that the velocity operator on the left of this equation has the proper value equal to the velocity of light. Finally, these expressions suggest that a solution of certain difficulties, which appear to indicate the necessity of a quantized space-time, is to be found, not in an intrinsic property of the space of physics, which possibly has no properties except those given to it by the geometer, but in an intrinsic property of matter.

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Pulse Excitation of Impedance Bridges

IN the measurement of resistance in a Wheatstone bridge it is customary to use either D.C. or sinusoidal A.C. as excitation. The former is inconvenient if it is desired to use a valve amplifier as the bridge detector; the latter requires a balance of the residual quadrature component and does not indicate directly the sign of the out-of-balance condition of the bridge.

It has been found that for certain purposes the use of rectangular pulses of suitable length and recurrence frequency as excitation for a bridge offers some advantages. In the case of a resistive bridge with stray capacitance shunting one or more arms, the presence of the capacitance causes a spike with an exponential decay at the beginning and end of the pulse, which appears at the output terminals of the bridge, while the plateau which follows the spike gives a correct indication of the resistive balance condition. Investigation shows that measurements can be made in many practical cases with pulses of from 1 to 10 microsec.; while with sinusoidal excitation under similar conditions frequencies as low as 150 c./s. may be required to make the quadrature component in the bridge output negligible.

One of the most important advantages of the method is that it enables a number of bridges to be excited in sequence and their output applied to a common amplifier. This is the subject of a provisional patent application (J. G. Yates and Elliott Bros. (London), Ltd., No. 22756/47) in connexion with multi-channel resistance strain-gauge equipment. In particular, this avoids the problems of low-level electronic switching for the bridge outputs and replaces it by the easier problem of pulsing the bridge inputs.

The use of pulse excitation is not restricted to the measurement of resistance. For example, the use of pulse excitation in a capacity bridge can provide a convenient method of distinguishing between series and shunt losses in the condenser without requiring measurements at several frequencies.

Some experimental work has been done in collaboration with the Research Laboratories of Elliott Bros. (London), Ltd., and it is hoped to publish further details later.

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Acclimatization to Cold in the Antarctic

DURING a year spent as medical officer to the Falkland Islands Dependencies Survey in the Antarctic at Marguerite Bay, I had the opportunity of making some observations on cold acclimatization in eleven men.

In winter and spring, the temperature varied mainly between 0° and − 35° F., though in summer temperatures just above freezing were common in the day-time. It was found that as the weather grew progressively colder with the advent of winter, little additional clothing was required. A fair amount of individual variation in clothing worn was noted, though for any given individual little increase in clothing was necessary. One man, for example, wore a string vest, long woollen underpants, an army shirt, silk scarf, socks, boots, gloves, cap with protection for the ears, thin windproof trousers and anorak (windproof upper garment with hood). This was worn for outdoor walking at temperatures down to 0° F. In colder weather later in the year, a long-sleeved sweater, warmer footgear and gloves were all that was necessary in addition. Apart from the footwear and protection for the ears, this was less than the same man was accustomed to wear in England in winter.

In winter, very exceptionally, the temperature rose from the region of − 20° F. to + 32° F. overnight, and most of the men complained of the discomfort of this relative heat wave.

Difficulties in attempting physiological research on a polar expedition are legion and account for a curtailment of the programme of investigation.

Some of the investigations were to verify interesting results reported by Frazier of the United States Antarctic Service[1], who quotes Lockhart's work. It was found, for example, that the basal metabolic rate in winter at the base in the Ross Sea was lowered paradoxically. Siple has attributed this low rate to a hibernation mechanism. It is, however, logical that in low environmental temperatures the basal metabolic rate should be raised to provide a greater output of body heat. It is a well-established fact that there is a marked rise in the metabolic rate when an animal is chilled[2,3], and this rise is attributable to an increased secretion of adrenaline with increased muscular tone and shivering[3,4]. Many observers have recorded a seasonal change, the basal metabolic rate being raised in winter and lowered in summer[5,2]. Martin[6] has observed a lowered basal metabolic rate in the tropics. Crile[7] records a raised basal metabolic rate in Eskimo, but this may be due to the specific dynamic action of a meat diet. Basal metabolic rate estimations made in winter in the Antarctic at Marguerite Bay showed an average increase of 5 per cent over a set of normal controls with the same apparatus. All estimations were made with the subject comfortably warm in bed. A likely explanation of the discrepancy between these results and those of Lockhart may be that the difference is due to a relative overheating of the United States Antarctic Service huts.

Correlated with a raised basal metabolic rate and increased adrenaline activity, one might expect a raised blood-sugar level, as is found in animal experiments[8]. Lockhart is reported to have found a raised blood-sugar level in his subjects[1]. I found an average increase of 10 mgm. per cent in the fasting blood-sugar, determined by the method of Hagedorn and Jensen, in the comfortably warm subject in winter in the Antarctic.

Frazier[1] noted an increased liability to shock following injection of a preparation of novocaine with adrenaline as a local anæsthetic. He suggested that this might be due to an increased sensitivity to adrenaline, whereby the cold-acclimatized man utilizes his adrenaline to fullest advantage. This possibility was investigated by injecting intravenously 1 c.c. of 1 in 150,000 adrenaline over a period of 90 sec. A slight increase in sensitivity as indicated by changes in the blood pressure, respiration-rate, pulse-rate and subjective sensations was noted in the cold-acclimatized man.

The capacity to work with exposed hands at low temperatures varies considerably. The physiological factor involved appears to be the reaction of the peripheral vessels to exposure to cold[9]. The reaction of the peripheral vessels to cold is influenced by the basal metabolic rate, there being less vasoconstriction if it is high[10]. A variable increase in blood pressure results from the immersion of an arm in ice-cold water for one minute (cold pressor test). This increase in blood pressure is due to stimulation of the vasomotor centre by cooled blood and by afferent impulses from the cooled skin, resulting in generalized peripheral vasoconstriction, including constriction of the digital arteries and arterioles[11]. To a lesser degree this rise in blood pressure may be due to the local effect of cold on the arterioles of the cooled hand. Fifteen men of the Falkland Islands Dependencies Survey were arbitrarily graded according to their tolerance to exposure of the hands to cold. It was observed that those who responded to the cold pressor test by a marked rise in the blood pressure suffered badly from cold hands. However, a man that suffered more than the average from cold hands did not necessarily show hyper-reaction to the cold pressor test.

In conclusion, I should like to pay a tribute to the fortitude of my comrades, who were prepared to be made the subjects of the investigations under trying conditions.

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[1] Frazier, R. G., *Proc. Amer. Phil. Soc.*, United States Antarctic Service Report, **89**, No. 1, 249 (1945).

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Effect of Oxygen on the Frequency of Chromosome Aberrations Produced by Alpha-Rays

In testing the hypothesis that the effect of ionizing radiations on the growth-rate of *Vicia faba* root tips is primarily due to the production of chromosome aberrations, we have shown[1] that X-irradiation under anaerobic conditions has a much reduced effect on growth, and that this is accompanied by a considerable reduction in the number of cells showing bridges or fragments at anaphase. We have now done an analogous experiment with alpha-radiation, using a modification of the method of Gray and Read[2] of immersing the roots in radon solution. Four graded doses were given to groups of eight beans in oxygen-free water, and four in water that contained 12 c.c. oxygen per litre. The mean growth of the groups of roots in the ten days following irradiation is plotted against dose in Fig. 1, together with comparable curves obtained after X-irradiation. We note that oxygen has a much greater influence on the effect of X-rays than on the effect of alpha-rays, the dose ratios for equal growth 'without/with oxygen' being $\sim 2{\cdot}5$ and $\sim 1{\cdot}3$ respectively.

For the cytological study, two radon seeds of equal strength were selected, and the conditions of the two irradiations were kept alike, except that the water contained 12 c.c. oxygen per litre in one case and none in the other. The application of a few small corrections resulted in estimates of the doses of 7·66 energy units[3] with oxygen, and 8·02 energy units without oxygen. Root tips were fixed at intervals up to 72 hours after treatment. Feulgen squashes were made, and a hundred anaphases were examined in each to determine the percentage that showed bridges or fragments. At six times of graph 1 and seven of graph 2 the data were obtained from two root tips, and, at the remainder, from one. Except in one case the two data have been combined, as their mean was within the standard deviation of each. The results, Fig. 2, suggest that the yield of aberra-

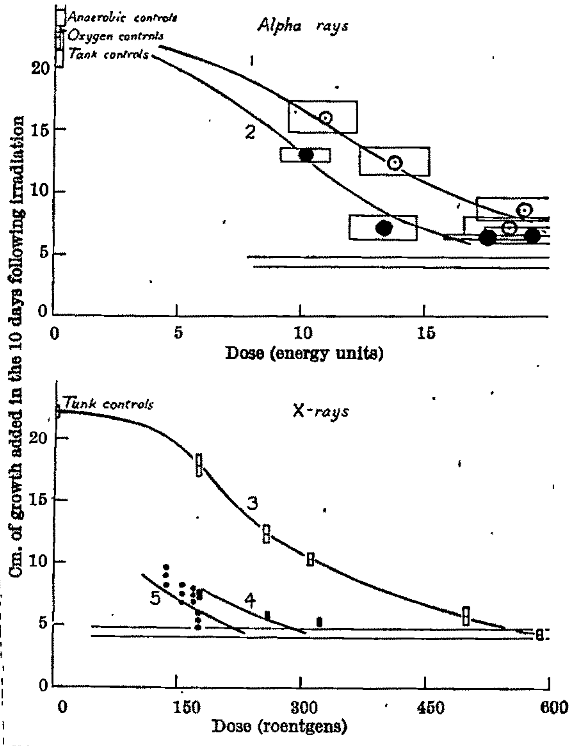

Fig. 1. Each point is the mean growth in ten days subsequent to irradiation of groups of 6 to 9 bean roots. The standard deviation is marked by a vertical line. 10 per cent of the alpha-ray dose has been considered the equivalent of a standard deviation. 1, Alpha-rays, zero oxygen concentration; 2, alpha-rays, 12 c.c. oxygen per litre; 3, X-rays, zero oxygen in the water; 4, X-rays, 6 c.c. oxygen per litre; 5, X-rays, 12 c.c. oxygen per litre. The horizontal lines at growths of 4 and 4·8 cm. illustrate the mean growth in length, with standard deviation, of a group of roots which all die as a result of irradiation, and represents the extension due to the elongation of existing cells, a process insensitive to radiation. All the curves, therefore, terminate in this zone

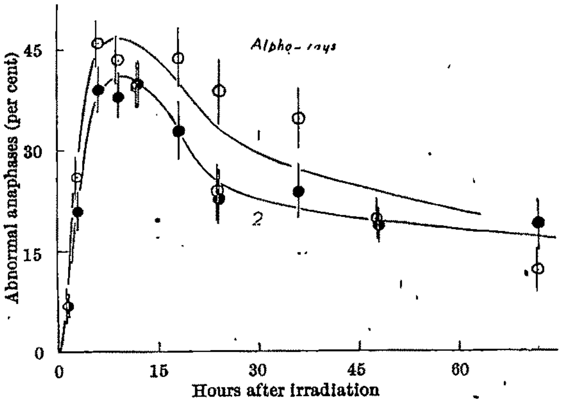

Fig. 2. 1, Dose, 7·7 energy units; oxygen content 12 c.c. per litre. 2, Dose, 8·0 energy units; oxygen content zero

tions when oxygen is present is somewhat greater than in its absence, but there can be no doubt that the increase due to oxygen is far less than that shown when X-rays are used (ref. 1, Fig. 2).

As before, we find a close correlation between the effects of different treatments on growth-rate and on the number of chromosome aberrations produced.

The effects of oxygen on the production of chromosome aberrations in *Vicia* by X- and alpha-radiations parallel its effects in promoting the decomposition of water by these radiations. Experiments summarized by Allsopp[4] and Lea[5] support the conclusion that pure oxygen-free water is not decomposed by X-rays, but if there is dissolved oxygen then hydrogen peroxide is produced. Alpha-rays, on the other hand, can produce hydrogen peroxide whether oxygen be present or not. Our results, therefore, suggest that hydrogen peroxide has some influence on the processes involved in chromosome structural change. We regard Mottram's[6] observation that cyanide increases the sensitivity of roots to X-rays as supporting this conclusion, since the inhibition of catalase or peroxidase may be expected to increase the effective concentration of hydrogen peroxide. It is, of course, impossible at this stage to decide whether hydrogen peroxide is the agent effecting chromosome breakage, or whether it merely influences the behaviour of broken chromosomes. The evidence of Kotval and Gray[7] that there is some spread of the effect of an alpha-particle may be held to favour the former alternative. On the other hand, we have evidence that oxygen increases the inhibition of mitosis by X-rays, and that while it increases the stickiness produced by X-rays it does not seem to affect the stickiness produced by alpha-rays, facts which might be held to favour the second alternative.

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Total X-Irradiation of Rats under Urethane Anæsthesia

The therapeutic use of urethane in human leukæmias, discovered by Paterson, Ap Thomas, Haddow and Watkinson[1], has led many authors to study the action of urethane in comparison with that of X-rays. However, treatment of patients by X-rays *during* the period of urethane administration was mentioned for the first time by Vannotti[2] in two cases of myeloid leukæmia. More recently, Dustin and Simon[3] have obtained promising results in chronic myelogenous leukæmia by splenic irradiation concurrently with administration of urethane (2–3 gm. a day).

In 1925, Hawkins and Murphy[4] pointed out, in a footnote to their study of ethylurethane anæsthesia and acid-base equilibrium of the blood, that "rats under urethane anæsthesia irradiated by a dose of X-rays far below the lethal dose, died invariably between the 7th and 14th day". No technical detail was given, and these experiments do not seem to have been repeated. Recently, Paterson[5] found no cumulative action of urethane and X-rays either on fern spores or on fibroblast cultures.

In view of the potential clinical importance of the simultaneous application of urethane and X-rays, an attempt has been made to confirm the observations of Hawkins and Murphy.

To compare results of different experiments, the dose of radiation killing 50 per cent of the animals within 14 days (L.D. 50/14 days) was chosen in preference to that required to kill all the animals within the same time (absolute lethal dose, Ellinger[6]).

The rats used were of an albino strain and of weights ranging from 90 gm. to 140 gm. Each experiment was conducted with groups being irradiated under the same conditions. Rats for irradiation were placed in cardboard boxes divided into separate compartments. Preliminary experiments had shown an L.D. 50/14 days of 600 r., although it is evident that this value may vary with the strain, the age and the weight of the animals as well as with the conditions of the experiment. Following treatment, records were kept of the body-weight.

Irradiation, measured with an ionometer, was performed as follows: (1) rats irradiated with 500 r.: 200 kV. 8 mA.; focus-target, 60 cm.; filtration, 0·5 mm. copper + 1 mm. aluminium (rate, 29 r./min.); (2) rats irradiated with 600 r.: 200 kV. 10 mA.; focus-target, 80 cm.; filtration, 0·5 mm. copper + 1 mm. aluminium (rate, 20 r./min.). Rats in each group received the same dose.

Urethane was injected intraperitoneally, as in Hawkins and Murphy's report, using 1 c.c. of 10 per cent urethane solution per 100 gm. body-weight. Under these conditions, anæsthesia occurs very promptly. Irradiation of anæsthetized animals was made half an hour after urethane injection at the same time as the controls. Each rat was later kept in a separate cage.

Irradiation with 600 r. proved to be the L.D. 50/14 days for the control series.

Irradiation with a dose of 500 r. killed about 20 per cent of the animals within 14 days, both controls and anæsthetized. Thus, it could scarcely be said that a dose of X-rays far below the lethal dose kills all the rats under urethane anæsthesia, as 500 r. is within 20 per cent of the L.D. 50/14 days.

Irradiation with the L.D. 50 (600 r.), on the contrary, demonstrated a notable difference between the control and anæsthetized animals: while 50 per cent of the controls died within 14 days, 90 per cent of the anæsthetized rats died within the same period. Hence, if there is any lethal cumulative effect or sensitization resulting from association of urethane anæsthesia with whole-body irradiation, it can only be observed within a range close to the L.D. 50/14 days. If, however, Hawkins and Murphy's test of mortality was the absolute lethal dose, the cumulative effect would have seemed important, since a dose of X-rays, two-thirds of the absolute lethal dose, would have produced in urethanized animals about the same effect as the absolute lethal dose in control rats.

To determine whether urethane anæsthesia sensitizes to X-rays, or acts cumulatively, experiments should be carried out by administering urethane after irradiation. Further research is proceeding along these lines.

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A Contracture in Isolated Mammalian Muscle

Recently, Goffart and Brown[1] have shown that the effectiveness of adrenaline in increasing the twitch tension of the isolated rat's diaphragm preparation is inversely proportional to the amount of potassium ion in the bath. In continuation of these experiments, I have been studying the responses of the rat's diaphragm preparation immersed in potassium-free Tyrode's solution.

Administration of adrenaline ($1:10^5$–$1:10^6$) causes the usual increase in twitch tension, but this may be followed by a progressive delay in relaxation. The delayed relaxation of the muscle shows itself in the first place by a reduction of the 'overthrow' of the light spring-loaded lever used for recording. The 'overthrow' is usually increased during the potentiation of twitch tension, which is the first effect of adrenaline. If the fluid in the bath is left unchanged, the 'overthrow' is seen gradually to decline, until, some 20 min. after giving adrenaline, relaxation is clearly diphasic, a rapid initial phase being followed by a slow return of the lever to the base line. The first phase of relaxation then becomes shorter, and the slow phase starts nearer the peak of the contraction curve. The delayed relaxation is not accompanied by conducted repetitive action potentials, and appears, therefore, to be of the nature of a true contracture.

The only observed changes in action potential were similar to those described by Brown, Bülbring and Burns[2]. The contracture can be produced in fully curarized muscle stimulated directly and appears, therefore, to be of purely muscular origin. It is increased by increasing the calcium chloride content of the bath fluid from the normal 0·02 per cent to 0·06 per cent, and is at first increased and then suppressed by addition of potassium chloride to give a final concentration of 0·04 per cent. Although the contracture can be generally produced by addition of adrenaline, the latter is not invariably necessary, since prolonged stimulation of a preparation in potassium-free Tyrode's solution may produce it; adrenaline appears to accelerate the process. The contracture is increased by using lower frequencies of stimulation (< 1 in 10 sec.) and may be suppressed by increasing the frequency of stimulation from 1 in 10 sec. to 1 per sec. High concentrations of atropine and quinine ($1 : 10^4$) eventually suppress the contracture, and it is also very sensitive to changes in temperature: cooling by 0·5° C. may increase it, and warming the preparation by 1° C. may remove it.

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Utilization of Folic Acid Conjugate in Man

Heinle and Welch[1] have already made some observations on the utilization of folic acid conjugate. They did not observe formation of free folic acid from pteroyl-hepta-glutamic acid after incubation of the latter product with normal gastric or duodenal juice.

We have repeated this investigation and have found that the hepta conjugate is altered by normal gastric juice, although no free folic acid could be demonstrated (Buyze and Engel[2]).

If the incubation product of gastric juice on folic acid conjugate from yeast is incubated with rat liver conjugase prepared according to Mims, Totter and Day[3], no free folic acid was formed. This was not due to conjugase inhibitors present in gastric juice or yeast extract, as has been demonstrated[2]. This alteration of folic acid hepta conjugate into another 'conjugate' by normal gastric juice was not brought about by gastric juice of pernicious anæmia patients. The gastric juice of a sprue patient behaved like a normal human gastric juice in this respect. Normal duodenal juice was not active against pteroyl-hepta-glutamic acid or the conjugate formed by the gastric juice.

Olson, Fager, Burris and Elvehjem[4] have demonstrated that pteroyl-glutamic acid was present in rat liver not only in the form of its hepta conjugate but also in another conjugated form. It was possible to obtain free pteroyl-glutamic acid from the latter by incubation with liver homogenate. It appeared that from the gastric juice incubation product also free folic acid could be obtained by incubation with rat liver homogenate at *p*H 7.

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Antigenic Activity of Myosin and Actin

To our knowledge, the immunological behaviour of contractile muscle proteins has not been investigated. We immunized three rabbits and three dogs with rabbit's myosin prepared by the method of Szent-Györgyi[1]. We used intraperitoneal injections of 2·5 per cent myosin solution, the myosin being dissolved in 0·4 *M* potassium chloride. The animals received 0·5 gm. of myosin in increasing doses during seventeen days; they lost no weight during the treatment. With these antisera, precipitation tests were performed with the following antigens: rabbit's myosin, *F*-actin, *G*-actin, *F*-actomyosin and normal rabbit serum. The same tests carried out before treatment with normal sera of animals afterwards immunized served as controls. The results are seen in Table 1.

Table 1

	Myosin	Rabbits' *F*-actin	*G*-actin	*F*-actomyosin	Serum protein
Rabbit 1	—	—	—	—	—
„ 2	—	—	—	—	—
„ 3	—	—	—	—	—
Dog 1	+ + + 1: 500	—	—	+ +1 : 125	—
„ 2	± 1: 4000 + 1: 2000 + + 1: 1000 + + + 1: 500	—	—	+ +1 : 1000	—
„ 3	—	—	—	—	—

Rabbits' myosin injected into rabbits intraperitoneally did not incite antibody formation; this indicates that the presence of myosin in the blood of the same species does not lead to the production of *iso*antibodies. We succeeded in obtaining myosin antisera from two of the immunized dogs. The immune sera did not react with *F*- and *G*-actin; this indicates that the myosin prepared by the method of Szent-Györgyi is free from actin. *F*-actomyosin reacts with the antisera for myosin; this may be explained either by the presence of free polar groups of the myosin molecule in the actomyosin, or by the presence of free unchanged myosin molecules in the antigen solution after the linkage between actin and myosin. The probability of the latter explanation seems to be corroborated by the lower precipitation titre of myosin antisera with actomyosin and by the circumstance that—according to Szent-Györgyi—actomyosin does not represent a stoichiometrically definable compound.

In further experiments, we used *G*-actin from rabbits' muscle prepared by the method of Straub[1]. Three rabbits and three dogs were immunized with 0·3–0·6 per cent water solutions of *G*-actin. The animals received intraperitoneally 120 mgm. actin in increasing doses during seventeen days. Three weeks later, precipitation tests were made using the same antigens as in the previous experiment.

Table 2

Rabbit	Myosin	*F*-actin	Rabbits' *G*-actin	*F*-actomyosin	Serum protein
1	—	—	—	—	—
2	—	+1 : 500 + + +1 : 250	+1 : 500 + + +1 : 250	+1 : 500 + + +1 : 250	—
3	—	+1 : 2000	+1 : 2000	+1 : 1000	—
Dog					
1	—	+1 : 2000	+1 : 2000	+1 : 2000	—
2	—	—	—	—	—
3	—	+ + +1 : 250	+ + +1 : 250	+ + +1 : 250	—

The sera of two immunized rabbits precipitated rabbits' actomyosin with a relatively high titre. It follows that rabbits' actin administered to rabbits parenterally incites antibody formation, that is to say, it represents an *iso*antigenic, organ-specific protein. The antisera of dogs and rabbits reacted equally with *F*-actin; this indicates that the activation of actin did not result in any changes in the antigenic (chemical) structure of *G*-actin. Antisera for myosin and actin behave similarly towards actomyosin.

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Determination of Adrenaline in Blood Plasma by the Fluorescence Method

Among chemical methods for determining adrenaline in blood the fluorescence method seems superior[1-6]. It has been used in two basically different versions: either blood plasma[3,4] or a dialysate of hæmolysed blood[1,2,5,6] has been analysed. It is noteworthy that the first method gives much higher values than the second.

Theoretical objections may be raised against adrenaline determinations on dialysates of hæmolysed blood, since the supposed state of equilibrium on both sides of the membrane after four hours of dialysis is assumed, based on the fact that the adrenaline concentration in the outer liquid attains its maximum after four hours. As adrenaline cannot be determined in hæmolysed blood, simultaneous control determinations in the impermeate are impossible. Also the eventuality that the adrenaline might be bound to the protein and, therefore, hindered from dialysing through the membrane has been overlooked. Keeping these factors in mind, we have found occasion to compare the two methods more closely.

In so doing we used a modification of Lehmann's and Michaelis' method[3,7], which has the essential advantage that, by using a Beckmann spectrophotometer with an accessory fluorescence set, readings are easier to take and less subjective. This method yielded reproducible results; determinations on plasma with known adrenaline contents and on plasma with a known quantity of adrenaline added gave results closely corresponding to calculated ones.

Determinations were made on plasma and blood by the method of dialysis, and directly on plasma. This showed that the dialysis method yields values in the dialysate which closely correspond to those obtained by other authors in tests on hæmolysed blood, namely, approximately 0·07 μgm./ml. A small decrease was noted in the plasma impermeate which, in this case, may be analysed in parallel to the dialysate. The concentration was, however, of the same magnitude as that found in analysing untreated plasma, namely, 1–3 μgm./ml. Therefore only some few per cent of the adrenaline had passed through the membrane. The same low values in the dialysate were obtained in testing hæmolysed blood. Analogous tests on aqueous solutions of adrenaline showed the outer and inner liquids to be in equilibrium after four hours.

This observation leads us to conclude that the two modifications of the fluorescence method give incompatible results. In one case, free dialysable adrenaline is determined, whereas in the other total adrenaline contents, including both free and protein-bound adrenaline. The existence of both these forms of adrenaline is probably of the greatest importance for the biological activity of this substance in the tissues.

A more comprehensive report will be published in due course.

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Bilateral Asymmetry Shown by the Metachronal Waves in Protochordate Gill Slits

MULLER[1] stated that metachronal waves travelled round the gill slits of *Amphioxus* "am vordern Rande aufwarts, am hinten abwarts"; but he figured them moving in the opposite direction on the left side of the pharynx. Franz[2] did not clear up the contradiction, though he, too, noted and figured the metachronal waves. Fedele[3], in a figure of the gonozoid of *Doliolum mulleri*, indicated by arrows the movement of the metachronal waves around the stigmata. The movement appeared anti-clockwise on both sides, seen from outside the pharynx. McGinitie[4], examining the pharynx of *Ascidia californica* through the transparent test, also noted that the motion was anticlockwise. Since he did not state from which side of the animal this observation was made, it might be inferred that the direction appeared the same from both sides; but McGinitie did not specifically affirm this nor did he direct attention to the functional asymmetry implied. If the animal were bilaterally symmetrical in this respect, the movement would appear anticlockwise from one side but clockwise from the other, like the wheels of a car in motion.

During work on the development of *Saccoglossus*, carried out in collaboration with Mr. C. Burden Jones, University College of North Wales, Bangor, it was noted that the metachronal waves in the primary gill pores moved anticlockwise on both sides, as seen from the exterior. In adult *Saccoglossus*, as in *Amphioxus*, the shape of the gill slits is greatly modified by the down-growth of the tongue bars, yet the movement of the waves is uninterrupted and their direction is the same as in the larva. It was observed by opening the pharynx in the mid-ventral line, viewing the gill slits from within and waiting for the cilia to resume activity. From this point of view the motion appeared clockwise. The pharynx in young specimens of *Ciona intestinalis* and *Ascidia aspersa* was examined through the transparent test. The waves which moved around each stigma appeared anticlockwise on both sides of these animals. Mr. D. P. Wilson kindly informed us that in *Amphioxus* the direction of the metachronal waves is clearly anticlockwise on both sides, seen through the transparent body wall. Muller's figure is therefore correct, but his statement, quoted above, applies only to the gill slits of the right side.

Hitherto, *Amphioxus* has provided the only strong link between the Hemichordata and Urochordata in respect of the structure of the pharynx, so it is noteworthy to find, in the activity of the lateral cilia, a point of detail common to all three Protochordate groups. A similar asymmetry is shown by the velar cilia in Gastropod larvæ having a bilobed velum, but this is only to be expected, for the lobes are the parts of a single velum around which the waves travel uninterruptedly. There is no reason to believe that gill slits have been derived from unpaired structures, and the significance of the asymmetry in Protochordates is much more obscure.

According to Fedele[3], the activity of the lateral cilia in *Doliolum* imparts a rotation to the current of water which passes through each stigma. This causes the column of water within the pharynx to rotate, forming a vortex which plays a part in directing into the narrow entrance to the œsophagus the mucous strings by which the food is collected. It appears, therefore, that in this form the asymmetry in the gill slits may indirectly assist the feeding mechanism. In *Salpa*, however, the numerous feeding strings are sucked into a similar vortex produced by the ciliary activity of the œsophagus and intestine[5]. To judge from Fedele's account, this mechanism, which is essentially the same as that in *Doliolum*, operates in *Salpa* without the aid of the functional asymmetry under review here. It is therefore doubtful whether this asymmetry is of great importance even in *Doliolum*. Outside the Thaliacea, it appears to be entirely non-adaptive, yet its general occurrence suggests that it was present in ancestral Chordates. The following considerations suggest a possible direction in which the cause of its origin might be sought.

In the larva of *Saccoglossus* and in the *Tornaria* there is a belt of large cilia, the telotroch, encircling the body immediately behind the primary gill slits. Well-marked metachronal waves travel around it anticlockwise, as seen from the animal pole[6], that is, up the left side of the body and down the right. Soon after the first gill slits appear, the telotroch starts to regress, but in *Ptychodera bahamensis* it can be distinguished for some time after metamorphosis, and it is carried backwards as the trunk elongates so that each of the early gill slits appears in turn immediately in front of it[7]. The first gill slits, therefore, develop in the immediate proximity of a strong ciliary field which is continuously active. It is possible that the bilateral asymmetry in the ciliary mechanism of the gill slits is associated in some way with that of the telotroch. As they develop, the posterior borders of the gill slits immediately adjoin the telotroch. The metachronal waves on these posterior borders come to move in the same direction as did those of the telotroch, upwards on the left side, downwards on the right.

The activity of the telotroch causes the larvæ of *Enteropneusta* to rotate about the longitudinal axis in a clockwise direction viewed from the animal pole[6]. The rotation and the movement of the metachronal waves are associated phenomena. An exactly similar rotation has been observed in the early larva of *Amphioxus*[8,9], a fact which suggests the existence there of a similarly orientated ciliary field. This, in turn, suggests that such a field may have been present in the larvæ of ancestral Chordates.

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A Simple Medium for Cultivation of *V. choleræ*

The nutritional requirements of *V. choleræ* have been studied with the object of developing a simple medium capable of giving a massive growth of the organism which could be used directly as a vaccine. The investigations were on the lines followed by Linton and Jennings[1-3]. It was found possible to obtain concentrations as high as 14,000 million organisms per ml. of *Inaba* or *Ogawa* strains of *V. choleræ* maintained at this Institute by the following method.

A 2-litre flask containing the following was autoclaved: sodium chloride, 8 gm.; potassium chloride, 0·2 gm.; calcium chloride, 0·4 gm.; magnesium chloride, 0·2 gm.; sodium dihydrogen phosphate, 0·06 gm.; ammonium sulphate, 5 gm.; magnesium sulphate, 0·1 gm.; and distilled water, 1,000 ml. To this was added 30 ml. of 33⅓ per cent glucose solution and 27·5 ml. of 0·1 per cent *l*-cystine. The latter was made by dissolving 100 mgm. of *l*-cystine in 30 ml. of $N/10$ sodium hydroxide, which was then made up to 100 ml. with distilled water. To the mixture was added 5 ml. of a 5 per cent solution of 'Marmite' paste in distilled water. The solutions of glucose, *l*-cystine and 'Marmite' were sterilized by steaming. 11 gm. of sodium bicarbonate powder, sterilized by autoclaving, was added to the mixture and shaken until all the bicarbonate dissolved. The final *p*H of the medium was 8·8.

About 60 ml. of the medium was removed for purposes of subpassage, etc., and the remaining 1,000 ml. inoculated with 10,000 million organisms of *V. choleræ*; either *Inaba* or *Ogawa* strains or a mixture of 5,000 million organisms of each were used. The best results were obtained with an inoculum of an eight to twelve hours culture of the organism which had undergone at least six serial passages in the above medium and become adapted to it. The flask was incubated at 37° C. At the end of 10, 16 and 24 hr., 12 ml. of glucose solution and 9 gm. of sterile sodium bicarbonate were added to the cultures, shaken well and returned to the incubator. With the above method it was possible to obtain concentrations of 12,000–14,000 million organisms per ml. of both the strains at the end of 30 hours incubation.

The ammonium sulphate in the medium served as a buffer. Without the addition of ammonium sulphate, growth started earlier but ceased at the end of 10 hours when the *p*H reached 6·7. By periodic neutralization of the medium with sodium bicarbonate, it was possible to maintain the *p*H in the vicinity of 8, with a marked increase in the growth of vibrios.

The salts used in the medium had a beneficial effect on the growth of *V. choleræ*. Of the several amino-acids tried, *l*-cystine had a beneficial effect. Addition of tryptophan was necessary for the cultures to give the cholera red reaction. 'Marmite' paste had a marked growth-promoting effect on the organism. Substitution of 'Marmite' with thiamine hydrochloride, nicotinic acid, pyridoxine hydrochloride, calcium pantothenate, riboflavin, biotin and yeast nucleic acid, singly or in combination, did not give equally good results.

Cultures need not be shaken periodically except while adding extra quantities of glucose and sodium bicarbonate. Periodic shaking of the cultures or bubbling of air or oxygen through them did not improve the growth. Bubbling of carbon dioxide had a deleterious effect on the cultures.

Concentrations of 12,000–14,000 million organisms per ml. were obtained when the organism was grown in 3-litre quantities in a 4-litre flask.

The above medium, without the addition of ammonium sulphate and magnesium sulphate and adjusted to *p*H 8·8 with sodium bicarbonate, was found to be better than Dunham's peptone water for the isolation of *V. choleræ*.

Cultures containing 14,000 million organisms per ml. were rendered sterile by the addition of 0·5 per cent phenol and incubation at 37° C. for 24 hours. The antigenic value of these cultures is under investigation.

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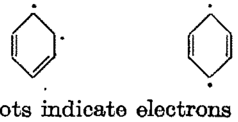
Reactive Structures of Hydrocarbons and Catalytic Hydrogenation

A carbon atom in its ground-state has the structure $1s^2 2s^2 2p^2$, ^3P. In such a state, the spins of the *p* electrons are coupled to unity. Penney[1] has shown that in order to obtain a divalent carbon atom, that is, one in which the spins are free, a mixture of the ^1D and ^3P states in the ratio 1 : 3 must be considered. The energy of attaining such a structure is the promotional energy. Such a structure has no independent existence, but arises from a perturbation of the carbon atom by the atom with which it is going to form a bond.

The concept may be extended to ethylene and to conjugated and aromatic systems. A reactive structure may be thought of as having two electrons with free spin at the given positions. Thus, for benzene there are two possibilities:



where the dots indicate electrons the spins of which are essentially free. The reaction structure may be thought of as a combination of singlet and triplet in the ratio 1 : 3. For any position in any molecule, that is, for any reactive structure, the energy may then be written in the form:

$$E_r = (1{\cdot}5 + n_r - n_p)\alpha, \qquad (1)$$

where α is the valence-bond exchange integral and n_r and n_p are the coefficients of α in the expression for the resonance energies of the reactant and product molecules respectively.

It would appear likely that the concept of the reactive structure might prove useful in a discussion of homolytic bicentric reactions between a series of molecules and a common reaction partner. Catalytic hydrogenation would appear to be a reasonable reaction to choose "since all the observed facts are in harmony with the conception that the catalyst in hydrogenation combines with both the hydrogen acceptor and the hydrogen"[2].

The main feature of catalytic hydrogenation may be explained on the basis of the reactive structure. The ease of hydrogenation of an isolated double bond follows at once from the low E_r for such a reaction ($n_r = n_p = 0$). On the other hand, the resistance of benzene to catalytic hydrogenation can be explained in terms of the large value of E_r, due to n_r being much greater than n_p. However, in the event of two atoms of hydrogen being added, E_r for the further addition becomes considerably decreased, and this is evidenced by the tendency for complete reduction of a benzene ring in a polycyclic compound. In general, the difficulty of reduction of conjugated systems relative to an isolated double bond is explicable in terms of n_r being greater than n_p, leading to large values of E_r. Another example of the use of the concept is afforded by the relative indifference to the position of addition in the case of butadiene, for in this case E_r is the same for both $CH_2{=}CH{-}CH{-}CH_2$ and $CH_2{-}CH{=}CH{-}CH_2$.

The concept of the reactive structure lends theoretical support to the assumption used by Pauling and Sherman[3] in their discussion of conjugated systems. These authors assumed that the product will be formed the more readily the greater its thermodynamic stability. This hypothesis was used in a discussion of the position of hydrogenation within a given molecule, and follows directly from (1). The purpose of the present note is to provide a basis for a discussion of relative ease of hydrogenation.

A fuller discussion of this subject will be presented elsewhere in due course.

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Estimation of Polymer Distribution on the Basis of Differences between the Average Molecular Weights of Different Order

IT is well known that the magnitude of the difference between the number and weight average molecular weight (M_n and M_w) in a polymer affords an indication of the degree of polydispersity. In order to obtain a numerical measure of the spread of molecular weights, and to reconstruct the distribution, the assumption is often made—though admissible only under certain conditions—that the distribution function is that of the log normal law[1-3], where the ratio between averages (the rth roots of the rth moments about zero) of successive order is an exponential function of the logarithm of the geometric standard deviation, which is equal to the standard deviation of the logarithmic distribution.

It has, however, so far escaped observation that from a knowledge of M_n and M_w the standard deviation of the molecular weights can be calculated directly and exactly without any assumption whatsoever about the distribution law.

Defining M_n as

$$M_n = \frac{\Sigma M_i n_i}{\Sigma n_i},$$

as obtained, for example, by the osmotic pressure method; and M_w as

$$M_w = \frac{\Sigma M_i g_i}{\Sigma g_i} = \frac{\Sigma M_i^2 n_i}{\Sigma M_i n_i},$$

as obtained, for example, by the light scattering method, where n_i, g_i are the frequencies and weights, respectively, of the molecular species M_i, we form the product

$$M_n M_w = \frac{\Sigma M_i n_i}{\Sigma n_i} \times \frac{\Sigma M_i^2 n_i}{\Sigma M_i n_i} = \frac{\Sigma M_i^2 n_i}{\Sigma n_i}.$$

Since

$$\sigma_n = \sqrt{\frac{\Sigma M_i^2 n_i}{\Sigma n_i} - \left(\frac{\Sigma M_i n_i}{\Sigma n_i}\right)^2},$$

we have at once for the standard deviation of the number distribution:

$$\sigma_n = \sqrt{M_n M_w - M_n^2}.$$

Similarly, if in addition to M_w, M_z is defined by

$$M_z = \frac{\Sigma M_i^2 g_i}{\Sigma M_i g_i} = \frac{\Sigma M_i^3 n_i}{\Sigma M_i^2 n_i},$$

as obtained, for example, by the sedimentation equilibrium method (if the concentration gradient is observed by the refractive index method), we form again the product

$$M_w M_z = \frac{\Sigma M_i g_i}{\Sigma g_i} \times \frac{\Sigma M_i^2 g_i}{\Sigma M_i g_i} = \frac{\Sigma M_i^2 g_i}{\Sigma g_i},$$

and have for the standard deviation of the weight distribution

$$\sigma_g = \sqrt{M_w M_z - M_w^2}.$$

Knowing the mean and the standard deviation in either number or weight distribution of molecular weights, we are in a position to obtain a conservative estimate of the whole distribution by using the so-called Tchebycheff inequality[4]. According to that relation, the proportion of molecules with molecular weights differing from the mean weight by an amount not exceeding ± t times the standard deviation is, at least, $1 - 1/t^2$. By substituting arbitrary values for t ($5 > t > 1$), and subtracting the proportion for the smaller t from that for the next higher one, we obtain the relative frequencies (number distribution) or the weight fractions (weight distribution) of the molecular weight species at the specified distances from the mean.

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July 5.

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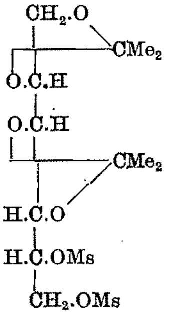
Reaction of Vicinal Dimesyl Compounds with Sodium Iodide, and its Application to the Interconversion of Hexitols

THE recent paper of Karrer and Davis[1] prompts us to report some work of a similar nature, on which we have been recently engaged.

Previous investigators[2-4] have shown that treatment of a compound containing two or more vicinal tosyloxy groups, with sodium iodide, leads to the elimination of all these groups, whether primary or secondary, with formation of an unsaturated compound, and the liberation of iodine. We have been using this type of reaction mainly for the preparation of intermediates for the synthesis of polyhydroxy dithiols (cf. Evans and Owen[5]), and have found that it is equally applicable to mesyl (methanesulphonyl) compounds.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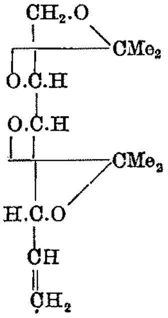
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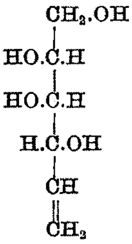
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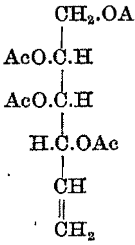
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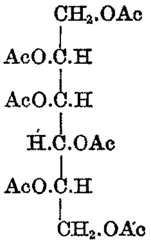
V

(Ms = $CH_3.SO_2$—)

Treatment of 5 : 6-dimesyl 1 : 2-3 : 4-diacetone D-mannitol (I) (m.p. 117·5–120°, $[\alpha]_D^{20°}$ + 25·1° ; all rotations in this communication were determined in chloroform solution unless otherwise stated) with sodium iodide in acetone solution at 100° gave a 65·5 per cent yield of 1 : 2-3 : 4-diacetone 5 : 6-mannitoleen (II), a colourless liquid, b.p. 41°/0·1 mm., $n_D^{23°}$ 1·4401, $[\alpha]_D^{21°}$ − 5·49° (found : C, 63·4 ; H, 8·6. $C_{12}H_{20}O_4$ requires C, 63·1 ; H, 8·8 per cent), together with a small amount of 5 : 6-mannitoleen (III), (Karrer's D-*arabo*-3 : 4 : 5 : 6-tetrahydroxyhex-1-ene), m.p. 147–149°, $[\alpha]_D^{20°}$ + 30·9° (water). Hydrolysis of the diacetone compound in the usual way gave a 69 per cent yield of 5 : 6-mannitoleen, [tetra-acetate (IV) m.p. 80–81°, $[\alpha]_D^{21.5°}$ + 49·4°]. Karrer and Davis[1], who employed 5 : 6-ditosyl 1 : 2-3 : 4-diacetone mannitol as starting material in a similar reaction, failed to isolate diacetone mannitoleen, and obtained only mannitoleen in 26 per cent yield.

Similar treatment of 5 : 6-dimesyl 1 : 3-2 : 4-diethylidene sorbitol with sodium iodide gave a theoretical yield of 1 : 3-2 : 4-diethylidene 5 : 6-sorbitoleen, m.p. 122–123°, $[\alpha]_D^{21°}$ − 21·6° (found : C, 60·4 ; H, 7·9. $C_{10}H_{16}O_4$ requires C, 60·1 ; H, 8·1 per cent), acid hydrolysis of which afforded 5 : 6-sorbitoleen (97 per cent yield), a colourless syrup, b.p. 100–130° (bath)/10^{-4} mm., $n_D^{15°}$ 1·5068, $[\alpha]_D^{19°}$ + 19·8° (water) (found : C, 48·5 ; H, 8·3. $C_6H_{12}O_4$ requires C, 48·6 ; H, 8·2 per cent) (tetra-acetate, m.p. 57–58·5°, $[\alpha]_D^{22°}$ − 13·6°). 5 : 6-Ditosyl 1 : 3-2 : 4-diethylidene sorbitol gave the same products, though in poorer yield.

Incidental to the main work, the following new method for the interconversion of hexitols has been evolved. Treatment of 5 : 6-mannitoleen tetra-acetate with hypobromous acid, according to the method of Raphael[6], and reaction of the crude bromohydrin with a mixture of acetic acid, acetic anhydride, and fused sodium acetate, yielded D-sorbitol hexa-acetate (V), m.p. and mixed m.p. 97–98°, $[\alpha]_D^{20°}$ + 9·04°. No mannitol hexa-acetate, the other possible product, could be detected. Similarly, from sorbitoleen tetra-acetate, L-iditol hexa-acetate, m.p. 119–120°, $[\alpha]_D^{22°}$ − 26·8°, was obtained, no sorbitol hexa-acetate being encountered.

Full details will be published elsewhere. One of us (P. B.) desires to thank the Department of Scientific and Industrial Research for a maintenance grant.

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Nov. 8.

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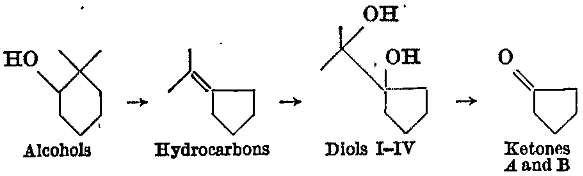
Position of the Hydroxyl Group in Lanosterol

DEHYDRATION of alcohols of the lanosterol series to the corresponding hydrocarbons has recently been reported by us[1], when the action of both phosphorus pentachloride and phosphorus oxychloride was described. Dihydroagnosterol and dihydrolanosterol, when treated with phosphorus pentachloride, gave *iso*-agnostadiene ('iso-γ-lanostatriene'), $C_{30}H_{48}$, and *iso*-lanostadiene, $C_{30}H_{50}$, respectively, and hydrocarbons isomeric with the above dehydration products were obtained with phosphorus oxychloride. We expressed the opinion, based on a consideration of analogous cases in triterpene chemistry, that the phosphorus pentachloride dehydration involved a retropinacoline rearrangement accompanied by a contraction of the terminal ring *A* of lanosterol, and stated that experiments to confirm this view were in progress. In the meantime, Ruzicka *et al.*[2], following our method of preparation, have reported the results of oxidation experiments on the dehydration product from dihydrolanosterol, and afforded evidence in support of the reaction mechanism suggested above, establishing at the same time the position of the secondary hydroxyl group in lanosterol. The continuation of our work has involved the study of the same series of reactions applied both to *iso*-agnostadiene and *iso*-lanostadiene, and in view of Ruzicka's publication, we now present a brief summary of our results.

Iso-agnostadiene, when oxidized with osmium tetroxide, gave a mixture of two diols of formula $C_{30}H_{50}O_2$, which differ only in the steric configuration of their hydroxyl groups and were separated by chromatographic analysis. Both *diol I*, $C_{30}H_{50}O_2$, m.p. 140–142° (found: C, 80·97; H, 11·47 per cent; $C_{30}H_{50}O_2$ requires: C, 81·45; H, 11·31 per cent), and *diol II*, $C_{30}H_{50}O_2$, m.p. 128–130° (found: C, 80·68; H, 11·20 per cent), gave, on oxidation with lead tetra-acetate, the *ketone A*, $C_{27}H_{42}O$, m.p. 85–87° (found: C, 84·51; H, 10·59 per cent; $C_{27}H_{42}O$ requires: C, 84·82; H, 10·99 per cent), while acetone (isolated as the 2-4-dinitrophenylhydrazone) was obtained in almost theoretical yields. The same series of reactions was carried out with *iso*-lanostadiene, yielding diols III and IV, $C_{30}H_{52}O_2$, and the corresponding ketone *B*, $C_{27}H_{44}O$ (Ruzicka's substance V), the constants of which were in essential agreement with the values given by Ruzicka *et al.* (*loc. cit.*). *Iso*-agnostadiene and *iso*-lanostadiene were further subjected to ozonolysis, when acetone and the respective ketones *A* and *B* were obtained in one stage.



The loss of acetone with formation of a ketone, when the diols obtained by osmium tetroxide oxidation of *iso*-agnostadiene and *iso*-lanostadiene are further oxidized with lead tetra-acetate, indicates the presence of a terminal *iso*-propylidene grouping in these hydrocarbons. The retropinacoline rearrangement occurring when triterpenoid alcohols are dehydrated with phosphorus pentachloride[3] thus takes place also in the analogous formation of *iso*-agnostadiene and *iso*-lanostadiene, and establishes the location of the hydroxyl group in the lanosterol molecule in the terminal ring, in a position adjacent to the *gem.*-dimethyl group. A detailed account of this work will appear elsewhere in due course.

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Specific Solvents for Lower Rank Bituminous Coals

In the course of recent studies of the effect of solvents on bituminous coals, a number of solvents have been found to share with pyridine and with ethylene diamine[1] the property of extracting a considerable quantity of coal at atmospheric temperatures. The difference between these and other solvents is sufficiently marked to warrant their designation as specific solvents for coal. The main types of specific solvent appear to be: (1) aliphatic compounds containing at least one primary amino group; (2) aromatic compounds containing at least one primary amino group attached to an aliphatic side-chain; (3) certain heterocyclic nitrogen compounds, such as pyridine, piperidine, morpholine (but not piperazine or pyrrole). The specificity of the interaction is emphasized when piperazine and dioxan (inactive) are compared with morpholine and piperidine (active). Slow diffusion of the solvent through the solid often tends to obscure the issue, especially with solvents of high viscosity.

Sufficient solvents have not yet been tested to enable a hypothesis to be formulated. It is already evident that the effect is complex, depending probably upon a suitable combination of at least two properties, one promoting swelling and loosening of the structure, the other solution. At room temperature many compounds (for example, phosphorus oxychloride and ethylene oxide) cause pronounced swelling, but little or no solution; the reverse combination has not been observed. The apparent dependence of solution upon swelling has also been noted by Losikov[2]; a general connexion between the two phenomena, as regards different ranks of coal, was found by several earlier investigators[3].

It is of interest to consider the extraction[1] of lower rank coals with ethylene diamine at its boiling point in the light of Kiebler's generalization[4] that the percentage of bituminous coals extracted by a number of different solvents at a given temperature is correlated with the internal pressure of the solvent better than with any other physical property. There are many conspicuous exceptions to this rule (for example, water), which give too low a yield. Direct comparison is not possible since Kiebler's results are expressed in the form of four correlation lines representing experiments at 150° C., 200° C., 150° C. and 300° C. respectively, whereas ethylene diamine boils at about 117° C. However, if points taken from Kiebler's lines (extended where necessary) at the appropriate internal pressure (117 cal./c.c.) are plotted against temperature, and the resulting curve is extended to 117° C., the expected yield appears to be less than one-third of that obtained experimentally.

Pyridine, which extracts coal at room temperature, and aniline, which is effective only at higher temperatures, both occupy similar relative positions (above the average) in Kiebler's correlation. The differences between these classes probably tend to decrease at higher temperatures. But it seems reasonable to treat the specific solvents (such as ethylene diamine) as a class distinct from those of intermediate solvent power, and from those which are exceptionally inactive, like water.

It is clear that whereas, in such solvents as water and the glycols, hydrogen bonds linking hydroxyl groups contribute largely to the latent heat of vaporization (and therefore to the internal pressure), their presence does not impart the power of functioning as a solvent for coal.

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Aug. 17.

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CHEMOTHERAPY OF FILARIASIS

WORKERS engaged in the search of a cure for filarioid infestations in man and animals will welcome the publication* of a symposium of fifteen papers by thirty-eight contributors who attended a conference on "The Chemotherapy of Filariasis" under the auspices of the Section of Biology of the New York Academy of Sciences on October 17 and 18, 1947. The term 'filariasis' in this publication signifies an infestation with a member of the nematode super-family Filarioidea. The use of this term recalls the days when the nematodes recovered from the lymphatic, circulatory or connective tissues or from the serous cavities of man and the lower vertebrates were all grouped in the genus *Filaria*, Mueller, 1787. Purists in medical and veterinary sciences, adopting the present-day classifications of taxonomy in biology, may maintain rightly that the term 'filariasis' should no longer be employed to indicate all infestations due to members of the genera *Onchocerca, Loa, Wuchereria, Acanthocheilonema, Mansonella, Dirofilaria*, etc. The use of the terms 'onchocerciasis', 'loaiasis', etc., indicates specifically the genera involved.

L. T. Coggeshall deals briefly with the history of filariasis due to *W. bancrofti* in the United States, and discusses symptomatology, pathology, immunology, prophylaxis and control. He includes remarks on loaiasis, onchocerciasis and dracontiasis. Filarioid infestations are, as a rule, chronic in character. Clinical manifestations may not become evident for years. There is still controversy as to whether the induration of the tissues in cases of elephantiasis, induced by *W. bancrofti* and occasionally by *O. volvulus*, is not due to secondary bacterial invasion. Coggeshall observes that the pathological changes are not typical of streptococcal infections and that they do not respond to agents which have a specific effect on the streptococcus.

No marked degree of immunity against further re-infection has been detected in individuals already infested, and cases of the same individual being infested with two or more members of the super-family are not uncommon. Coggeshall estimates that up to two million human beings are infested with worms of this group, while other American workers claim that the victims number twenty million. The incidence in domestic animals (horse, ox, sheep, goat, pig, camel, dog, cat, etc.) is high and widespread even in temperate climates. There is no doubt that the efficiency, productivity and welfare of many countries in the tropics and subtropics are seriously impaired by filarioid infestations in man and his livestock.

The low mortality associated with these forms of helminthiasis has rendered the general public indifferent to the sufferings of the afflicted. In the endemic regions, the efforts of the public health authorities to control and eradicate these maladies by prophylactic measures are handicapped by many difficulties, and Coggeshall hopes that the discovery of an effective chemotherapeutic agent would facilitate the elimination of infections from the endemic areas.

The general experimental methods used in studying 'filaricides' are discussed by R. I. Hewitt. The cotton rat (*Sigmodon hispidus*), naturally infected with a filariid, *Litomosoides carinii*, has been found a most suitable experimental animal for testing the efficiency of 'filaricides'. Dogs, infected with the blood filariid, *Dirofilaria immitis*, are used for comparative and confirmative work; but they are considered too large for use in ordinary routine work. The estimation of the efficiency of a 'filaricide' against the species parasitizing the cotton rat is based on destruction of the microfilariæ and its action on the adult worms. Hewitt attributes the disappearance of the microfilariæ in infected cotton rats to the death of the adult worms and not to a direct action upon the microfilariæ. He experimented with various piperazine compounds and admits that the use of controlled quantitative infestations has many advantages over naturally established infections; he considers that the relationship between drug dosage and the intensity of infestation can be gauged best in standardized infections. He notes that the filariids of the cotton rat, dog and man belong to different genera and that the different worms may respond differently to the same drug; but he believes that the utilization of infected cotton rats for testing the filaricidal efficiency of drugs may facilitate the discovery of a 'cure' in man.

G. F. Otto and T. H. Maren discuss the use of arsenicals in filarioid infestations. The literature and their own investigations indicate that the trivalent organic arsenicals are active in both human and canine infestations. Arsenamide kills *D. immitis* in dogs and, in well-tolerated doses, has been found to destroy the microfilariæ of *W. bancrofti*. They add: "It remains to be determined whether or not the adults of *W. bancrofti* are killed by this treatment". H. W. Brown reports on the treatment of filariid infestations with anthiomaline in the dog, cotton rat and man, and records that this compound reduced permanently the microfilariæ counts in individuals infested with *W. bancrofti*. The necessity for repeated injections, and also its toxicity, limit its usefulness, and Brown considers it only 'a stepping-stone' to be replaced by an orally administered non-toxic remedy. James T. Culbertson concludes: "*Wuchereria bancrofti* can be eradicated from many patients by the intensive administration of any of the several compounds of antimony and arsenic". He records that the pentavalent antimonial, 'Neostibosan', is well tolerated by man and has a marked destructive effect on the worms.

Twenty-five volunteers suffering from onchocerciasis were treated by F. C. Barther, T. A. Burch, D. B. Cowie, L. L. Ashburn and F. J. Brady with trivalent antimony compounds ('Stibophen' and tartar emetic). They observed no decrease in the number of microfilariæ or loss of motility in the adult worms. In one case, the administration of tartar emetic, prepared from radioactive antimony, showed that antimony had been taken up by the worm in one nodule. Harry M. Rose deals with the tolerance of antimony and arsenic compounds in intensively treated patients. The drugs used were: 'Neostibosan', 'Neostam', 'Fuadin', 'Anthiomaline' (Specia), 'Anthiomaline' (Merck), urea, stebamine, tartar emetic and stebanose.

Ernest Bueding reports that cyanine dyes in concentrations as low as one in forty millions inhibit the oxidative metabolism of *L. carinii*. The lethal action of cyanines in the case of *L. carinii* infestations is attributed to inhibition of the respiratory metabolism. He observes that, in contrast to vertebrates, the metabolic characteristics of invertebrates may vary greatly from species to species, and that morphologically related parasites need not necessarily be sensitive to the same chemotherapeutic agents. He rightly observes that investigations of the biochemical characteristics of pathogenic parasites may lead to the replacement of the present empirical methods by more rational methods of treatment. Lawrence Peters records that certain cyanine dyes had no chemotherapeutic effect on *W. bancrofti* although they proved lethal to *L. carinii.* He believes that this must be attributed, not to the failure of the drug to reach *W. bancrofti,* but to a difference in the metabolic characters of the two species.

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* "The Chemotherapy of Filariasis", by various contributors. Vol. 50, art. 2. pp. 19–170 (*Ann. N.Y. Acad. Sci.*, 1948).

S. Kushner, L. M. Brancone, Hewitt, W. L. McEwen, Y. SubbaRow, H. W. Stewart, R. J. Turner and J. J. Denton discuss the preparation of the piperazine compounds used in the search for an active filaricide which can be administered orally and is non-metallic. Hewitt, D. E. White, Kushner, W. S. Wallace, Stewart and SubbaRow report on the 'filaricidal' properties of various piperazine compounds, particularly 'Hetrazan', in dogs and cotton rats. Several of the compounds produced immediate and sharp reductions in microfilaria counts in infected cotton rats when administered orally or intraperitoneally; sometimes relapses occurred. 'Hetrazan' was also lethal to the adult worms in dogs and cotton rats. These workers record that they failed to find dead worms at autopsy in some of the treated dogs, and it seems possible that these dogs were infested not with *D. immitis* but with *D. acutiuscula,* which occur in the subcutis and have been reported from the Canadian lynx (*Lynx canadensis*). They examined only the heart and lungs for dead worms. B. K. Harned, R. W. Cunningham, Sybella Halliday, R. E. Vessey, N. N. Yuda, Mary C. Clark and SubbaRow give the structural formula of 'Hetrazan', report on its toxicity for mice, rats, guinea pigs, rabbits, cats and dogs, and cite some of its pharmacological properties.

D. Santiago-Stevenson, J. Oliver-Gonzalez and Hewitt report on the treatment with 'Hetrazan', taken by the mouth, of twenty-six individuals infected with *W. bancrofti.* The dosage varied from 0·5 mgm. to 2 mgm. per kgm. of body-weight thrice daily for periods varying from three to twenty-two days. For optimum results they suggest a dosage of 2 mgm. per kgm. body-weight thrice daily for a period of two to three weeks. There was a rapid disappearance of microfilariæ from the blood, and the development of nodular swellings at certain points of the body, usually infested by the adult worms, is accepted as proof that the compound killed some of the adult worms.

A study of "The Chemotherapy of Filariasis" will reveal that the search for a cure for filarioid infestations in man and his stock cannot be conducted behind 'iron curtains'. The workers in the various fields of science must co-operate and collaborate more and more closely than is usually the case. A better knowledge of the chemical composition and the metabolism of the various helminths parasitizing man, animals and plants may contribute materially towards the discovery of 'cures' which will not only relieve, to some degree, the present world-wide shortages of food, but will also restore normal health to many all over the world. P. L. LEROUX

SOIL THERMODYNAMICS AND ROAD ENGINEERING

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THE movement of moisture in soil is of importance to the civil engineer owing to the effect which changes in moisture content may have on the strength and the volume of the soil. In the case of roads, both the stability and the riding qualities of the surface are involved.

The thermodynamics of the moisture contained in hygroscopic materials such as paper, tobacco and textiles has received considerable attention, and much has already been done, particularly by agricultural scientists, in applying this work to soils. A fundamental approach on these lines to the many problems associated with the transfer of moisture in road foundations is at present being made at the Road Research Laboratory.

The potential causing the migration of soil water may be regarded either as a hydraulic pressure or a vapour pressure gradient. Movements cease only when suction and vapour pressure conditions are in equilibrium with the acting gravitational field under the prevailing temperature conditions.

The curvature of each of the air/water interfaces in the soil pores is a function of the pressure change through the meniscus and of the relative humidity at the interface. The relationship between relative humidity is given to a close degree of approximation by the well-known Kelvin equation, which may be written,

$$\frac{\rho.R.\theta}{M} \cdot \log_e \frac{H}{100} = - \frac{2T}{r}. \qquad (1)$$

The actual change in pressure through the meniscus, $\rho.g.h = 2T/r$, can be expressed in terms of Schofield's *pF* function[1],

$$pF = \log_{10} h = \log_{10} \frac{2T}{\rho.r.g}. \qquad (2)$$

Equations (1) and (2) have been used by Schofield and others in the determination of the *pF* of soils at low moisture contents.

In the soil itself, the curvature of the air/water interfaces depends on the moisture content and on certain characteristics of the soil solids, the chief of which appears to be the particle-size distribution. It follows that the suction/moisture content and the relative humidity/moisture content relationships depend on soil type; and, in fact, the moisture contents of two dissimilar soils in moisture equilibrium may be greatly different. In road construction, where it is common on clay soils to use a stable sandy soil to form part of the road foundation, the suction/moisture content relationships are useful in estimating the equilibrium moisture (and strength) conditions.

Road foundations are subjected to both the daily and the yearly temperature cycles. It is therefore necessary to ascertain the effect of temperature on the suction and humidity relationships. The variation of the density of the soil water with temperature causes only a second-order variation in the radii of the air/water interfaces. Neglecting this variation, it follows from (2) that at two temperatures θ_1 and θ_2,

$$pF_{\theta_1} - pF_{\theta_2} = \log_{10} T_{\theta_1} - \log_{10} T_{\theta_2} + \log_{10} \rho_{\theta} - \log_{10} \rho_{\theta_1}. \qquad (3)$$

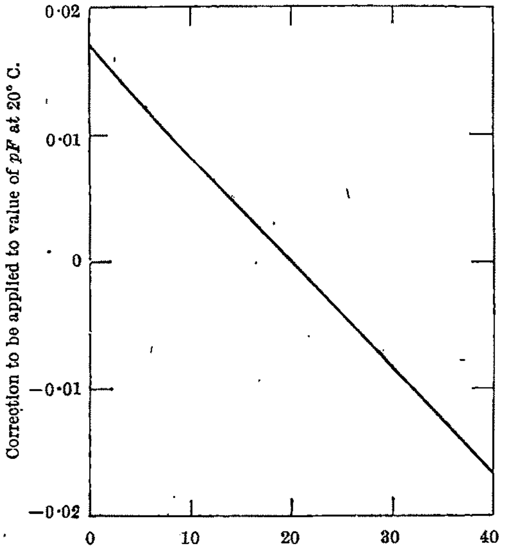

Fig. 1. Correction to be applied to pF of soil at 20° C. to obtain pF at other temperatures

Fig. 1, obtained from this equation, shows how small the suction difference associated with temperature gradients will be. The correspondingly small variation with temperature of the relative humidity of soil water follows from equation (1), since

$$\frac{\log_e H_{\theta_1}/100}{\log_e H_{\theta_2}/100} = \frac{T_{\theta_1}}{T_{\theta_2}} \cdot \frac{\theta_2}{\theta_1} \cdot \frac{\rho_{\theta_2}}{\rho_{\theta_1}}. \qquad (4)$$

This relationship is used to obtain Fig. 2.

The small change in relative humidity with temperature indicates that the vapour pressure of soil water varies with temperature in a manner similar to that of free water. A family of typical vapour pressure/temperature/moisture content curves is shown in Fig. 3. It follows that considerable vapour pressure gradients may be set up by comparatively small temperature differences. Further, since the relative humidity of soil water is sensibly different from 100 per cent only at moisture contents lower than those of interest to the road engineer, the following two conclusions can be reached:

(1) Differences in soil moisture content under the road will cause suction gradients virtually unaccompanied by vapour pressure gradients, and transfer will normally be in the liquid phase.

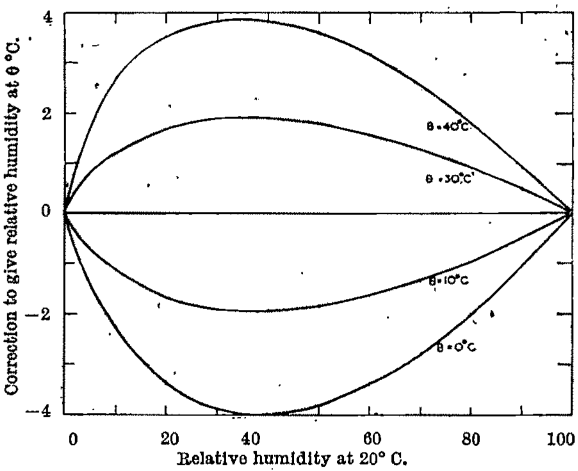

Fig. 2. Correction to be applied to relative humidity of soil at 20° C. to obtain relative humidity at other temperatures

(2) Differences in temperature will cause vapour pressure gradients but not appreciable suction gradients, and transfer will normally be in the vapour phase.

Interesting confirmation of these conclusions has been obtained in this Laboratory and from practical observations. The severe drought in 1947 caused an abnormal reduction in the moisture content of road verges. Transfer of moisture in the liquid phase resulted in severe settlement and cracking on a number of roads built on heavy clays. In some parts of the world, seasonal temperature gradients are such as to cause the upward migration of water from considerable depths. Reports have been received from arid regions of California of vegetation confined solely to the verges of roads where evaporation of moisture brought to the surface was prevented by the impermeable road metal.

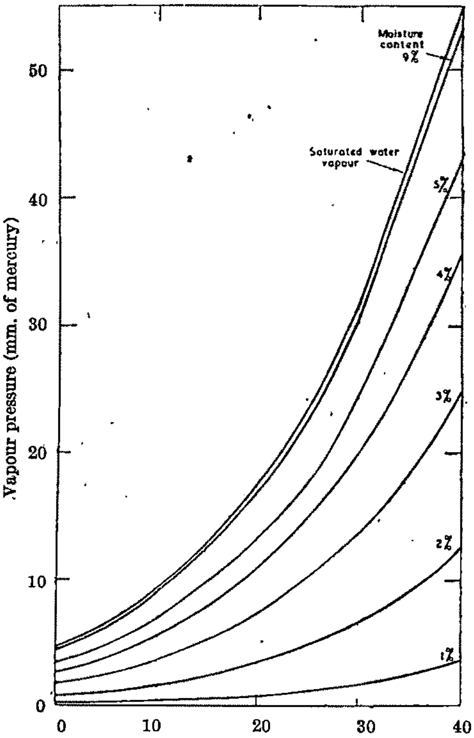

Fig. 3. Variation of soil vapour pressure with temperature

The problem of moisture transfer also involves consideration of the heat of wetting, the latent and specific heats of the soil water and the effect of temperature on each of these quantities. Detailed consideration has been given so far only to the heat of wetting. The differential heat of wetting of a hygroscopic material is obtained by Shorter[2] as

$$Q = -\frac{R\theta^2}{JM} \cdot \frac{\partial}{\partial\theta}\left[\log_e \frac{H}{100}\right]. \qquad (5)$$

Using the differential of equation (1)

$$Q = \frac{-R\theta^2}{JM} \cdot \left[\frac{1}{T} \cdot \frac{\partial T}{\partial\theta} - \frac{1}{\theta} - \frac{1}{\rho} \cdot \frac{\partial\rho}{\partial\theta}\right] \log_e \frac{H}{100}. \qquad (6)$$

Equation (6) enables the differential heat of wetting to be calculated at any given temperature. At temperatures θ_1 and θ_2, equations (6) and (4) give

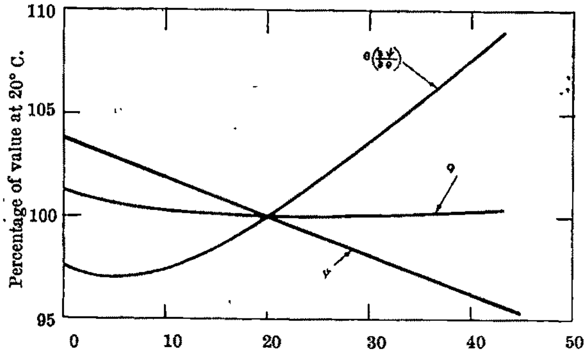

Fig. 4. Temperature variation of capillary potential, ψ, heat of wetting and bound energy, $\theta\,(\partial\psi/\partial\theta)$

$$Q_{\theta_1} = Q_{\theta_2}\frac{\left[\frac{1}{T_{\theta_1}}\left(\frac{\partial T}{\partial\theta}\right)_{\theta_1} - \frac{1}{\theta_1} - \frac{1}{\rho_{\theta_1}}\left(\frac{\partial\rho}{\partial\theta}\right)_{\theta_1}\right]\theta_1 \,.\, T_{\theta_1}\rho_{\theta_2}}{\left[\frac{1}{T_{\theta_2}}\left(\frac{\partial T}{\partial\theta}\right)_{\theta_2} - \frac{1}{\theta_2} - \frac{1}{\rho_{\theta_2}}\left(\frac{\partial\rho}{\partial\theta}\right)_{\theta_2}\right]\theta_2 \,.\, T_{\theta_2}\rho_{\theta_1}}. \tag{7}$$

Equation (5) can be written in the form

$$Q = \psi - \theta\, d\psi/d\theta,$$

where ψ, Buckingham's capillary potential, $-gh$, is given by

$$\psi = \frac{R.\theta}{M} \,.\, \log_e \frac{H}{100}.$$

In Fig. 4 the temperature variation of Q and each of its components ψ and $\theta\,.\,\partial\psi/\partial\theta$ is given. These curves are based on equation (7). The quantity $\partial T/\partial\theta$ was obtained from accurate surface tension data.

Further investigations are in hand, and it is hoped to publish a fuller account, including experimental results, in due course. The work is being undertaken as part of the programme of the Road Research Board, and the present note is published with the consent of the Director of Road Research.

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[3] Buckingham, E., U.S. Dept. Agric., Bur. Soils, Bull. No. 38 (1907).

DEVELOPMENTS IN PICTURE TELEGRAPHY

THE transmission of pictures by land-line over various distances has been the subject of experimental development since the earliest days of telegraphic communication; and the techniques involved have been adapted similarly for transmission or relaying over radio links. Amid the excitement of other applications in recent years, such as broadcasting, radar and television, the very advanced stage which has been attained by picture or facsimile telegraphy, as the technique is termed, is apt to be overlooked. Many systems have been suggested and experimented with; but they have had a common basis in that the picture to be transmitted is placed on a revolving drum and scanned with a suitable source of light and optical system. The variations in light intensity reflected or scattered by the varying tones of the picture are converted into a fluctuating electric current through the agency of a photoelectric cell. The resulting signals are transmitted by line or radio to the receiving station, where they may be converted by a current-sensitive oscillograph into light variations which record the picture on suitable photographic paper. Alternatively, the electric currents are made to reproduce the picture by an electrochemical process. In either case, the recording paper is mounted on a drum which is maintained in rotation synchronously with that at the transmitting station.

This technique of the transmission of pictures by telegraphy is used to a large and successful extent by the Press to obtain quickly the illustrations which accompany accounts of topical events all over the world. But there are other applications in industry and the public service; and one of these, the transmission of fingerprints by radio, has been referred to in *Nature*, **158**, 525 (1946).

The name of Muirhead has been associated for more than a century with the development of instruments used in various branches of telecommunications, including in recent years the very successful production of phototelegraphic equipment. At the recent symposium held by the Scientific Instrument Manufacturers Association of Great Britain, Ltd., a paper entitled "Some Developments in Picture Telegraphy" was presented by Mr. J. Bell, of Muirhead and Co., Ltd., who have also supplied some technical literature and bulletins giving further details of the equipment. For some time now a number of the larger newspapers have operated their own picture transmission circuits comprising telephone lines linking their editorial offices with various population centres; and Muirhead–Jarvis picture-telegraph transmitting and receiving equipment is now in operation in a large number of newspaper offices in Great Britain and northern Europe. The apparatus has been designed to conform with the requirements laid down by the Comité Consultatif International Télégraphique (C.C.I.T.), and it may therefore be worked with the principal phototelegraphic services abroad which conform to the same standards.

An amplitude-modulated form of transmission is used over wire circuits, while for radio links the principle of sub-carrier frequency-modulation is used, thereby ensuring that the signals representing the tone values of the picture are not greatly affected by fading and other disturbances of the radiofrequency carrier-wave during transmission. The picture transmission band is from 300 to 2,300 cycles per second and is thus easily within the scope of a normal telephone channel.

The standard equipment installed at the terminal fixed stations uses drum speeds of either 1 or 2 revolutions per second, and the picture is scanned at either 100 or 150 lines per inch (3·9 or 5·9 lines per mm.) for all normal requirements. Under these conditions, a picture of size 10½ in. by 10 in. (267 mm. by 254 mm.) can be transmitted in 16 min. 40 sec. and 25 min. respectively. For super-quality work, scanning at 300 lines per inch (11·8 lines per mm.) can be used, and the results obtained under these conditions are so accurate in detail as to render it difficult to distinguish the received picture from the original.

The use of normal telephone channels for the communication of news direct from the scene of the event has been followed by a demand for comparable facilities for the transmission of pictures, and the Muirhead–Belin portable transmitter has been developed to meet this demand. This equipment consists of two suit-case units, one of which contains the power unit operating either from the electricity supply mains or from a car-starter battery. The other unit comprises the transmitter, which conforms with the C.C.I.T. requirements as regards picture size, rate of scanning, synchronizing, phasing and speed of transmission; it can therefore be used in conjunction with any make of receiver similarly standardized. As with the fixed station equipment, the speed of the revolving drum carrying the picture is maintained constant by means of a special synchronizing circuit controlled by a temperature-compensated high-stability tuning fork. The frequency of this fork is 1,020 c./s., and this is used to modulate a sub-carrier signal of 1,300 c./s., which is transmitted down the line, to provide at the receiver a synchronizing signal which is independent of any changes occurring in the telephone carrier-signal.

There is also available a portable dark-room, comprising a small tent and full photographic facilities, and this is fitted up in two suit-cases for use with the portable picture transmitter. This equipment allows the processing of pictures to be carried out quickly and conveniently in any location.

The bulletins referred to above contain several photographic reproductions in support of the claim that "Muirhead machines are producing the best wired pictures in the world".

ANCIENT ARTS AND MODERN PARODIES

THE exhibition entitled "40,000 Years of Modern Art", which opened at the Academy Hall in Oxford Street, London, just before Christmas and closes at 10 p.m. on January 29, makes no claim to a scientific approach—to which, indeed, so cavalier a title would have been rather ill attuned—yet it possesses surpassing interest for anthropologists, and may well do a good service to science by inducing them, and other visitors, to look at primitive art in new ways under the shock of the juxtaposition with a sufficiently aggressive selection of modern paintings and sculptures. The Institute of Contemporary Arts, 6 Fitzroy Street, London, W.1, a recently formed body devoted to the good cause of encouraging new trends in all the arts (but the approach of which is perhaps not yet quite so wide as its scope), is to be warmly congratulated and thanked for assembling what is almost certainly the most impressive display of primitive art ever held in Great Britain outside the great ethnographical museums.

The selection, though partly conditioned by the desire to find parallels for the moderns, has not suffered unduly thereby, and there are only a few pieces (such as a dubious Easter Island figure) which seem to have been included less for their merit than their surrealism. Many, if not most, of the Oceanic and (especially) African pieces are of the very first class within their types; some cannot be paralleled here at all. The Pitt Rivers and Ashmolean Museums at Oxford, the Horniman Museum and the Brighton Museum have all made notable contributions, and the magnificent private collections of Mr. Webster Plass and Mr. W. O. Oldman have been drawn upon to excellent effect. Among the finest pieces are the most forceful of all Basonge masks (Belgian Congo), owned by Mr. R. Penrose; Mr. Plass' bust of a Baga fertility divinity (French Guinea); the Northern Yoruba earth goddess from the Horniman Museum; two large fetish figures of the eastern and western Belgian Congo from the Oldman collection; some fine reproductions from the Frobenius Institute at Frankfurt of Australian and African rock paintings; and an outstanding series of polychrome *malanggan* carvings from the New Ireland collection at Brighton. The word 'primitive' has been rather strictly interpreted, to exclude the barbaric 'civilizations' of West Africa, Indonesia and pre-Columbian America, and this has meant that certain forms of sculpture pre-eminently appropriate to this exhibition (such as the more mystical of the Benin bronzes) are unrepresented. Less easy to explain is the truly primitive sculpture of Borneo and other parts of the East Indies.

The declared purpose of the exhibition is to compare primitive and modern and to suggest a community of inspiration between them. But one's main impression on leaving the show (and this is confirmed by most of the art critics) is rather of antithesis. It is true that there are superficial resemblances of form (though many of those to which the organisers direct attention are, in fact, purely fortuitous); but fundamentally they are opposed in conception and function. Primitive art is everywhere (even in medieval Europe) an art of conformity, of devoted acceptance in both a spiritual and a material sense; the forms develop over hundreds, or even thousands, of years, by processes which are essentially evolutionary, and have a four-dimensional quality about them which arises from their conception not by a single artist, but by many generations of artists, not as an escape, but as at once the expression and the support of the social pattern. 'Modern' art, on the contrary, is to a large extent frankly revolutionary, and, moreover, is still, after forty years, in the destructive phase of anarchism, comparatively few artists having begun, like Henry Moore (who almost alone in this exhibition seems to hold his own with the peoples of Nature), to build the foundations of a new order amid the chaos; too many of them are iconoclasts, content to satirize our world by drawing, for their entirely intellectual inspiration, upon the form but not the content of the deeply religious art of the primitive peoples (with the same cynicism with which an atheistic totalitarianism will tolerate or even sponsor a subservient form of Christianity for its own ends). In this deeper sense, then, primitive art is actually nearer in spirit to the traditionalism of the Royal Academy than to the exuberance of its own imitators. Sincerity, it may be thought, is the most flattering form of imitation.

We may be all the more grateful to the Institute of Contemporary Arts for putting the moral so clearly before us that there is a virtual unanimity among both critics and members of the public. The Institute has thus laid a fine foundation for its future work, and we may look to it with confidence and hope for the constructive leadership which will not only give direction and stability to modern art in the post-Picasso era, but also make its contribution to a re-integration of the cultural elements in our schizophrenic society.

Two further words should be said: the arrangement of the exhibition, though bold and imaginative, strains perhaps a little too self-consciously after the sales technique of a show of industrial design, instead of the self-effacement proper to the display of works of art; and the catalogue (though not wholly innocent of the same tendency) contains an essay by W. G. Archer and Robert Melville which is a valuable stimulant to thought about primitive and modern art and their interrelations, and in which both artists and ethnologists may find not a few provocative sentences. We may hope that the collaboration between art and science will be pushed much further.

WILLIAM FAGG

SECULAR CHANGES IN THE EARTH'S MAGNETIC FIELD

DR. E. C. BULLARD has described (*Mon. Not. Roy. Astro. Soc.*, Geophys. Supp., 5, No. 7, July 1948) the rapid changes in the earth's magnetic field in South Africa, from which certain tentative conclusions are drawn. From data in tables 25, 29 and 33 in "Descriptions of the Earth's Main Magnetic Field and its Secular Changes", by E. H. Vestine and others (Carnegie Institution, Washington, 1947), a diagram is constructed showing the annual changes in the horizontal and vertical fields in South Africa at 1922·5; this date has been chosen because it is believed that the secular variations are better known then than at any other time.

From detailed calculations it seems possible that motions in the liquid core of the earth can partly explain the rapidity of change, though, as shown in the calculations, it is difficult to obtain a sufficient field by these means. Some of this difficulty, it is hoped, may be removed by a more thorough analysis of the secular change. The movement of the material of the earth's core through the general magnetic field of the earth could induce electric currents which produce the secular changes in the magnetic field, and the world-wide part of the change may be due to motions some thousands of kilometres in diameter. From 1843 to 1900 the change at Cape Town was comparatively small (0·02 gauss in all) and may not have been due to a local eddy.

No explanation is given regarding the causes of the motions in the liquid core, but it is suggested that radioactive generation of heat there might produce thermal convective currents. A similar effect would result from asymmetry in the earth's cooling, and another possibility is that the slipping of the outer part of the earth over the core, while the earth's rotation slows down by tidal friction, may have had some effect.

A full investigation of the theory proposed would be a tedious matter, and it is not suggested that it is complete at present, but it is hoped that it will "stimulate modifications that will agree more exactly with the very complicated facts".

RUBBER INDUSTRY IN GERMANY

THE B.I.O.S. Overall Report No. 7 on "The Rubber Industry in Germany during the Period 1939–1945" has recently been published (London: H.M. Stationery Office, 1948. 2*s*. 6*d*. net). This comprehensive report will be primarily the concern of the rubber technologist, but there are a number of aspects which will interest all scientific workers in the high-polymer field. Perhaps the most interesting is the heat sensitization of latex by the use of polyvinyl ether ('Igevin M50'), because the process depends upon the curious fact that this material is soluble in latex or water at room temperatures, but becomes insoluble at 35° C., and causes the rubber to coagulate as it separates out. 'Igevin M50' is used in 3–7 per cent concentration referred to the rubber content, and the mixed solution is indefinitely stable at 25° C., thus contrasting markedly with other heat-sensitizing materials.

The German synthetic rubber industry started long before the American industry, and it has been of interest to note that, in each case, the bulk of the synthetic rubber produced was of the butadiene–styrene type, with butadiene–acrylonitrile polymers running second. What has not been generally realized, however, is that the Germans also had a large number of varieties, not only of the butadiene–styrene type, but also of other types, and these are described on pages 22–30 of the report. Two promising polymers of which little has previously been heard are 'Buna K', a copolymer of butadiene and methyl vinyl ketone, and 'Buna M', where butadiene was polymerized with methyl methacrylate.

Another synthetic rubber which seems to show remarkable promise is 'Vulkollan N'. This is an ester-type rubber, prepared from polyethylene adipate and naphthalene di-*iso*cyanate, which it is claimed will render all other polyester rubbers obsolete, being non-hardening, of high tear-resistance, and having lower hysteresis. Its resistance to abrasion is said to be ten times that of natural rubber, the tear-resistance is 53 per cent higher, and the solvent resistance is equal to that of 'Perbunan'; it will be interesting to see whether the manufacture of this rubber can be made a commercial proposition.

In the field of testing, the Germans were actively aware of the prime importance of laboratory tests for the 'processability' of their polymers, and they developed many tests which will be of interest to those technologists who had to struggle with the intractable rubbers which were the early product of the American industry. Other subjects of particular interest to technologists are the new non-black reinforcing fillers 'Tonerdegel' and 'White Carbon', the account of abrasion machines, and the discussion of thermal plasticization.

R. G. NEWTON

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, January 24

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. P. Johnson: "The Ultracentrifuge and Electrophoresis Apparatus in Protein Research".* (Further Lectures on January 31, February 7 and February 14.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. C. G. Rossby: "Air Mass Meteorology—its Geographical Implications".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Generation of Electricity by Gas Turbine Plant".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Symposium on "Juvenile Delinquency".*

TEXTILE INSTITUTE, YORKSHIRE SECTION (at Alexandra Café, King Edward Street, Halifax), at 7.30 p.m.—Mr. F. L. Goodall: "The Battle against Textile Pests".

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Prof. N. V. Sidgwick, F.R.S.: "Some Remarks on the Periodic Table" (Alembic Club Lecture).

Tuesday, January 25

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10 a.m. and 2 p.m.—Conference on "Combined Heat and Power Supplies".*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Ian Hogbin: "Social Status in Melanesia".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. L. S. Penrose: "The Work of the Galton Laboratory".*

Institution of Electrical Engineers, South Midland Centre (at the Town Hall, Birmingham), at 6 p.m.—Sir Noel Ashbridge and Mr. H. Bishop: "Television" (Faraday Lecture). (To be repeated on Wednesday, February 2, at the Philharmonic Hall, Hope Street, Liverpool, at 6.45 p.m.; on Wednesday, February 9, at the Houldsworth Hall, 90 Deansgate, Manchester, at 7.30 p.m.; on Wednesday, February 16, at Central Hall, Westminster, London, S.W.1, at 6.30 p.m.; on Wednesday, March 16, at the De Montfort Hall, Leicester, at 7.15 p.m.; on Wednesday, March 23, at the City Hall, Sheffield, at 7 p.m.; on Tuesday, March 29, at the City Hall, Newcastle-upon-Tyne, at 7 p.m.; and on Tuesday, April 5, at the Central Hall, Tollcross, Edinburgh, at 7 p.m.)

Royal Institute of Chemistry, London and S.E. Counties Section (at High Duty Alloys, Ltd., Buckingham Avenue, Trading Estate, Slough), at 6 p.m.—Prof. H. V. A. Briscoe: "The Chemistry of Dusts".

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 6 p.m.—Discussion on "Rheological Methods of Control".

Manchester Geographical Society (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. J. Arnold Berry: "Three Indian Cities—Bombay, Agra and Delhi".

Wednesday, January 26

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Thomas Swarbrick: "The Application of Science to Fruit Growing".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting: Dr. G. M. B. Dobson, F.R.S.: "Ice in the Atmosphere".

Institution of Electrical Engineers, Radio Section (joint meeting with the Acoustics Group of the Physical Society, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. M. Payne: "The Development of Magnetic-Tape Recorders".

Linnean Society of London (in conjunction with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. J. Wilmott: "Botanical Taxonomy from Linnæus to Darwin".

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Mr. H. Stevenson: "Long Term Policy in Chemical Industry, especially in Textiles".

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Sir William J. Larke Medal Paper.

British Association of Chemists (in the Small Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Mr. F. A. Robinson: "Antibiotics".

Television Society (at the C.E.A., 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. M. Morgan: "Television Transmission and Reception at 480 Mc./s.".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Research Teams" (to be opened by Sir George Thomson, F.R.S., Sir Charles Harington, F.R.S., and Dr. H. O. Wansbrough-Jones).

Thursday, January 27

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Some Modern Views on Evolution".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Royal Greenwich Observatory".

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. H. W. Thompson, F.R.S.: "Infra-Red Measurements in Physics, Chemistry and Biology". (Further Lectures on February 3, February 10 and February 17.)

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. F. E. Jones: "Radar as an Aid to the Study of the Atmosphere".

Friday, January 28

Institution of Chemical Engineers, North-Western Branch (at the College of Technology, Manchester), at 2.30 p.m.—Annual General Meeting: Dr. F. A. Freeth, F.R.S.: "The Place of Heterogeneous Equilibrium in Chemical Engineering".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Chemical Society, Southampton Section (joint meeting with the Chemical Society of University College, Southampton, in the Physics Department, University College, Southampton), at 5 p.m.—Dr. R. P. Linstead, F.R.S.: "Some Aspects of Recent Work at the Chemical Research Laboratory, Teddington".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. F. Bergel: "Some Aspects of Pharmacological Chemistry".* (Further Lectures on February 4 and February 11.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Fluid Mixing by Jets and Cyclone Dust Collectors".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. H. G. Yates: "Vibration Diagnosis in Marine Geared Turbines".

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Dr. G. P. Sillitto: "The Design of some simple Physico-Chemical Experiments".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Mathematics, to teach up to B.Sc. General Degree standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (January 29).

Senior Biochemist or Biochemist—The House Governor, Royal Free Hospital, Gray's Inn Road, London, W.C.1 (January 31).

Readership in Old Javanese at the School of Oriental and African Studies—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 1).

Physicists and Electrical Engineers (unestablished, Senior Scientific Officer and Scientific Officer grades) at the Royal Aircraft Establishment, Farnborough, and other Ministry of Supply establishments in southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.436/48A (February 5).

Lecturer in Metallurgy in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (February 12).

Assistant Lecturer in Chemistry—The Registrar, The University, Sheffield (February 19).

Lecturer in Engineering with special interest in strength of materials and structures—The Secretary, The University, Aberdeen (February 21).

Senior Lecturer or Lecturer in Physiology in the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 1).

Chair of Anthropology at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 1).

Readership in Indian Philosophy at the School of Oriental and African Studies—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 28).

Director of the Rubber Research Scheme of Ceylon—The Chairman, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7 (March 31).

Director of the Institute of Social and Economic Research, University College, Ibadan, Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 (March 31).

Technical Assistant in Electronics—Dr. B. Bowden, Caius College, Cambridge.

Lecturer in Mechanical Engineering—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Social Anthropologist, for a study of the Ndebele of Southern Rhodesia—The Director, Rhodes-Livingstone Institute, P.O. Box 195, Livingstone, Northern Rhodesia.

Research Assistant for Biochemical Laboratories—The Secretary, Institute of Psychiatry (University of London), Maudsley Hospital, Denmark Hill, London, S.E.5.

Senior Entomologist, and Field Entomologists (3), in the East Africa Desert Locust Survey—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Physical Chemists (Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London, for work in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography, and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A.

Mechanical Engineer to take charge of a department of research on flax production—The Director, Linen Industry Research Association, Lambeg, Belfast.

Agricultural Chemist in the Department of Agriculture, Sierra Leone—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Higher Education for the People. By Christopher Meredith. Pp. viii+88. (London: Communist Party, 1948.) 3*s*. 6*d*. [99

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 3, No. 22: The Genus Primula: Sections Cuneifolio, Floribundae, Parryi and Auricula. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 631–686. (Edinburgh and London: Oliver and Boyd, 1948.) 14*s*. [149

Haven Products: a Scottish Experiment in the Employment of Severely Disabled Men. By A. E. Turner, T. A. Stirrat and F. Ferguson. Pp. iv+27. (London and Edinburgh: Nuffield Provincial Hospitals Trust, 1948.) [149

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PROBLEMS OF UNIVERSITY EXPANSION IN BRITAIN

DESPITE the general interest of the report of the University Grants Committee as a record of university development in Great Britain during 1935–47 (see p. 154 of this issue), and the picture it gives of the very considerable achievements of British universities both before and during the War, that part of the report which deals with post-war developments and problems is likely to receive most attention. None the less, the greatly increased scope of the activities of the University Grants Committee, to which the whole report bears witness, make it desirable that the early chapters should be read by a much wider public than those who may be immediately affected by the developments or special problems discussed later in the report. The scale on which the universities of Great Britain are now being assisted from national funds makes it imperative that the ordinary citizen should have a clear idea of how those funds are being spent and what the nation is receiving in return. Within its limits the report makes a valuable contribution to that end ; but it may well be held that an increasingly important function of the University Grants Committee in the future will be the interpretation, to the nation as well as to the Government, of the policies and the financial needs of the universities.

The two most impressive features of the present report are its revelation of the extent to which the expansion of the universities urged from many quarters during the War has already taken place, and the confidence of the Committee that the increasing dependence of the universities on State assistance and the central planning of university development so as best to promote the public welfare, at least on the lines indicated in the report, need not endanger academic autonomy. Already the number of students has risen from the pre-war 50,000 to some 77,000 as against the 88,000 which, ignoring financial considerations, the universities had estimated they would be able to deal with at the end of ten years. This latter estimate is only 2,000 short of the total recommended by the Barlow Committee ; and analysis of the figures by faculties indicates that in science and technology the pre-war numbers have already been doubled. Numbers in the faculties of arts, however, have risen by only about 50 per cent, although accommodation for arts students is not in general so limited as for science and technology, and in the arts faculties a higher proportion of applicants gains admission. The University Grants Committee, however, advances sound reasons for its doubts whether the arts faculties are likely in the remainder of the decade to expand by the 10,000 students required to achieve the proposed doubling of numbers in all faculties other than medicine.

The University Grants Committee is not unduly disturbed by the probability that for some years to come the proportion of students engaged in scientific and technological studies is likely to be higher than it was before the War. It points out that the proportions of students in these faculties have varied greatly in different universities, and that what is vital is that in each university the several disciplines should be represented in such proportions that members of the various faculties are brought into contact with students in other fields. Such contact becomes more difficult if the proportion of any one faculty is excessively low or high, and the University Grants Committee suggests that the proportion of arts students should not fall below one-third. It may well be, as suggested, a matter for examination whether the different ratios which have been temporarily established in the total student population in Great Britain during the post-war years represent what is desirable from the national point of view, and also whether it should remain constant. Much more important is the maintenance of quality, of conditions which make possible the effective mingling of the faculties and a proper relation between the number of students in the different faculties and their prospects of employment. These are the factors with which the University Grants Committee is concerned, and it is rightly insisted that the rate at which university expansion can wisely proceed must take full account of all three.

The question of quality naturally involves that of selection, and the Committee's observations on this point are appropriately considered in discussing the recommendations of the 'working party' on university awards (see *Nature*, January 22, p. 113). Next to the quality of the students, however, the maintenance of university standards depends on the quality of the life and education which the universities are able to offer. The University Grants Committee is very seriously concerned with the heavy strains which the rapid expansion has imposed on staff and students alike, and the consequent serious deterioration in the standards of university life. It rightly observes that conditions which may be tolerable for a short period become in time unendurable, and, while less cautious or pessimistic than the Nuffield College Committee in its recent statement, is convinced that unless additional accommodation can be speedily provided, the present numbers of students cannot be maintained without grave risk of impairing academic standards.

On these grounds, it is apparent that if the provision of the additional accommodation so urgently needed in the form of new teaching blocks, halls of residence, libraries and central amenities is not forthcoming when the present considerable proportion of ex-Service men declines, the Committee believes that the universities will be well advised to delay filling their places with younger undergraduates. Maintenance of the present overcrowded conditions with a less mature body of students involves the danger that the really outstanding people will be unable to reach the standards which were attained before the War. The view that provision of a leisured university life, with adequate opportunities for regular contacts between staff and students, should come before any expansion in numbers which denies such opportunities is supported by observations both from the point of view of graduate employment and of the expansion and conditions of the university staffs.

Although university education should not be regarded merely as a means of training for particular careers, some attention, as we have repeatedly urged, must be paid to the rate of expansion in the output from different faculties. While it is important that, besides equipping scientific workers, technologists and medical men for their work, the universities should provide men and women of trained intelligence and wide culture for the solution of social problems, the administration of public affairs and the enrichment of every sphere of human activity, a sense of frustration and disillusionment would be created if many graduates were unemployed, or employed in occupations which made no real or satisfying use of their abilities. It is clearly easier to estimate the future demand for graduates in science and technology; but even here, though much valuable work has been done, the survey is at present far from complete. On the imperfect data available, no more general inference is warranted than that although some adjustment of numbers as between different branches of science and technology may be required, no considerable increase in the present total of such students will be demanded in the foreseeable future.

On the other hand, the future demand for arts graduates is extremely problematic. Despite the reasonable contention that larger numbers of graduates in arts could be employed with advantage to the nation in local government administration, in industry and in commerce, the prospects of any rapid increase in any such openings are hazy. A changed mental attitude is required on the part of graduates, no less than on the part of local authorities and other employers. It is not easy even to estimate the number of recruits for the administrative class of the Civil Service who would be recruited from arts as distinct from science graduates. The University Grants Committee believes that the university appointments boards could make an important contribution; but in the meantime, firmly as it believes that it is essential for our national well-being that means should be devised to permit the recruitment into non-technical employment in industry of a steadily increasing proportion of university men and women, the Committee is right to utter the warning that the present numbers of arts students cannot be maintained or increased without the danger of creating unemployment, unless the avenues for employment are greatly widened.

That in itself may enforce early reconsideration of the balance of studies, as the Committee itself admits. Moreover, if the ratio between the faculties is to be changed without detriment to university standards, regard should be had to the content of the curriculum, especially perhaps so as to correct any tendency to narrowness of outlook on the side of science and technology, as well as to the means of ensuring contact between the students of different faculties, on which the University Grants Committee rightly lays considerable stress. It goes far, indeed, towards commending the suggestion which Sir George Arthur made in the foundation oration at Birkbeck College on March 28, 1946, that in every department one lecture should be given, or one paper read, every week or every month, by a student in another department, so that, by the time he took his degree, every student should know what the whole college was doing and have had some experience of the difficulty of conveying, in the language of common discourse, ideas familiar to us in the language of special discourse or technical terms. Humanists would learn how to make the language richer and more precise by the accurate use of scientific terms, and scientific men might discover that the King's English is a far more adequate medium even for conveying scientific ideas than they had hitherto supposed.

It is an important contribution to the discharge of the function of a university to see that every student knows something of what the university as a whole is doing and to keep the channels of communication between one mind and another open, and bright and clear; and it must profoundly influence the prospects of graduate employment as well as their employability. But its discharge depends in turn very largely on those questions of academic staff which are causing such serious concern to the University Grants Committee in regard to the maintenance of university standards.

The recruitment of academic staff in sufficient numbers to enable the universities to deal with their wider responsibilities is regarded as one of the most difficult problems confronting them. Apart from the increase in the number of students, there is a general desire to increase the ratio of staff to students, while a third reason for increasing the academic staff is the introduction of new subjects which call for the services of specialized teachers and research workers. No accurate measure has been obtained of the increase in full-time staff which would be required to meet these needs. At a rough guess, the University Grants Committee puts the total of full-time staff required at 10,000 as against a pre-war 4,000, assuming that student expansion on the scale contemplated is achieved by the end of the decennium; but it estimates 8,000 as the maximum that could be expected by the end of the quinquennium, without any firm confidence that this expectation will be realized. It points out that the suspension of normal university activities during the six years of war has left a gap in the production of men and women suitable for appointment as university teachers which will take years to repair. During the war years, moreover, many senior teachers remained at their posts after the normal age of retirement, while many other posts remained unfilled.

Temporarily, there is a demand much in excess of the supply of suitable candidates, and even if there is no further increase in the numbers of students, no marked improvement in the staff–student ratio appears likely during the present quinquennium. The present age-structure of the university staffs in Britain constitutes a further reason for caution. To-day, some fifty per cent are less than thirty-five years of age, and the University Grants Committee suggests that, while the Universities may be able to do little to remove the disproportion, they should attempt to plan future recruitment so as to secure a more uniform distribution over the ages from twenty-five to sixty-five. Furthermore, the reinforcement of staffs is dependent on the physical expansion of the universities, so as to provide conditions in which the staff are no longer handicapped by unsatisfactory environment.

There is no suggestion in the report that the heavy strain under which university staffs in Britain have been working during the last ten years has hindered recruitment; and the University Grants Committee appears to be confident that the marked improvements in the salaries of lecturers are adequate to attract a sufficient flow of candidates of the right type, though it points out that any substantial change in the value of money or in the standard of remuneration in comparable professions would lead to a situation requiring consideration of salary-levels. It lays more stress on the importance of associating the lecturer grades with the administrative work of the University, and of providing the senior members of the staff with secretarial or administrative assistance and with adequate technical assistance in the laboratory. Such means of relieving the senior members of duties which do not demand their personal attention are particularly important while it is difficult to obtain staff of sufficient seniority, and also to enable the universities to continue to give assistance in the development of university institutions in the Colonial territories that is being planned.

This sober review of university development is thus full of encouragement. Like the Nuffield College statement, it hints at the possibility that expansion may have to be re-timed, and that the rate of expansion may need to be modified. But the wide vision and the balance of the report warrant every confidence that the University Grants Committee will prove equal to its new and wider responsibilities, and that the expansion of the universities of Britain will be guided wisely and imaginatively. The Committee clearly intends that academic autonomy and standards shall not be impaired, and that the new opportunities of service to the community should be fully utilized. The contribution of the universities over the whole field of national life can repay increasingly those large appropriations for their support which are now made from the national exchequer.

VITAMINS AND HORMONES

Vitamins and Hormones

Advances in Research and Applications. Vol. 5. Edited by Prof. Robert S. Harris and Prof. Kenneth V. Thimann. Pp. xvi+478. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.50 dollars.

THE volume under consideration deals with many aspects of vitamins and hormones, and it will certainly be of the very greatest value to anyone involved in research in these particular fields, or who is teaching or preparing a text-book.

The first section, by Nicholas A. Milas, deals with the synthesis of vitamin A and related products. The bibliography is complete up to well into 1947. The article deals very thoroughly with the production of synthetic analogues, and a particularly clear account is given of the work on synthesis by Heilbron and his colleagues, and the relation of this work to that published by the Dutch investigators, Van Dorp and Arens.

It is not possible to review in detail all the sections, and passing over the very full and excellent account by Melnick and Oser of the physiological availability of the vitamins and Von Muralt's summary of the present position of vitamin B_1 in relation to peripheral neurophysiology, we come to William J. Darby's review of the position of pteroylglutamates in relation to human nutrition and disease. Workers in Great Britain and on the Continent of Europe have failed to realize the enormous concentration that has taken place in the United States on this work. Investigation of the extensive metabolic and hæmatological effects of folic acid constitutes only one small part of the work. Very extensive investigations have been made into the effect of folic acid in sprue, chronic diarrhœa, and various diseases of infancy and childhood. This summary will go a long way to prepare the British and Continental reader for the vast amount of work that will be published from now onwards in the journals of the United States. Efficient and excellent as this article is, it can only act as an introduction to this subject, since important questions, such as the anti-folic acid substances and their use in various conditions like leukæmia and in the treatment of malignant disease, are not touched upon.

Then follows a short chapter by H. R. Bird on the vitamin requirements of chicks. It is pointed out that this is important not only in the study of nutrition as a whole but also for "the more efficient and profitable production of this economically important animal". A rather longer chapter, by H. P. Morris, deals with the vitamin requirements of the mouse.

Choh Hao Li and H. M. Evans deal very thoroughly with the properties of the growth and adrenocorticotropic hormones. The methods of assay and of isolation, and the physical, chemical and biological properties of these two hormones are described. Then follows an article by C. W. Emmens and A. S. Parkes on the effect of exogenous œstrogens on the male mammal. This is very valuable in that it collects together the much scattered work on the effect of œstrogens on such varied functions as growth and sex differentiation and on other glands.

The chapter on the biology of antithyroid agents, by H. A. Charipper and A. S. Gordon deals very exhaustively with the effects of thiourea and its derivatives on the structure of the thyroid and pituitary glands in various species, on growth and general metabolism, on iodine metabolism, on enzyme systems, etc. The article also deals with the chemical nature of the antithyroid agents and their clinical applications.

The next chapter, on the use of androgens in women, by Anne C. Carter, E. J. Cohen and E. Shorr, describes the biological effects of androgens in women and their use in the treatment of various disorders.

The final article, by C. G. Heller and W. O. Maddock, deals with the clinical uses of testosterone in the male. The authors indicate the various ways in which hypogonadism can be diagnosed. They indicate the various methods of administration of testosterone, its biological effects and its clinical applications.

E. C. DODDS

MORE BESSEL FUNCTIONS

Tables of the Bessel Functions of the First Kind of Orders Ten, Eleven and Twelve

Pp. x+636.

Tables of the Bessel Functions of the First Kind of Orders Thirteen, Fourteen and Fifteen

Pp. x+616.

Tables of the Bessel Functions of the First Kind of Orders Sixteen through Twenty-seven

Pp. xi+764.

Tables of the Bessel Functions of the First Kind of Orders Twenty-eight through Thirty-nine

Pp. ix+694.

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vols. 7, 8, 9 and 10.) (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 55*s*. net each volume.

THESE four massive volumes contain a further very substantial instalment of the publication of the great table of the Bessel function $J_n(x)$, for values of x less than 100 and for integer orders n up to 100, which has been computed by means of the automatic sequence controlled calculator in the Computational Laboratory of Harvard University under the direction of Prof. H. Aiken. Previous volumes have been reviewed in these columns (*Nature*, **160**, 773; 1947), and five further volumes will be required to complete the project.

It will be noted that while volumes 7 and 8 (like their immediate predecessors) contain only three functions, volumes 9 and 10 each contain twelve. This is made possible by discontinuing the tabulation of values at intervals 0·001 in x for values of x less than 25, for orders above the fifteenth, and thereafter using a uniform interval 0·01. This will reduce to about three feet the present writer's earlier estimate of the length of bookshelf required to house the complete series. Except perhaps for the smaller values of x (where 10 decimals mean fewer than ten significant figures), it is unlikely that many users will often find inadequate the values within their range which the tables actually give; indeed, the provision is on a munificent scale.

Since the previous review was written, a systematic comparison has been made of values common to the Harvard tables and the tables, now in proof, to be published as "British Association Mathematical Tables", Vol. 10, and no error has been found in the Harvard tables.

In reviewing these volumes one cannot help contrasting the resources enjoyed by our American colleagues with those which have been at the disposal of workers in the same field on the eastern side of the Atlantic. But there is a danger that lavish resources may be wastefully used. The terms of the power series for $J_n(x)$ are numerically the same as those for $I_n(x)$, and an almost similar remark applies to the asymptotic series, including those for $Y_n(x)$ and $K_n(x)$, so that with slight modifications in procedure, and without proportional increase in time or labour, fundamental values for the other three functions over considerable ranges could conceivably have been produced concurrently with those for $J_n(x)$. However, let us be thankful for great mercies!

W. G. BICKLEY

A TEXT-BOOK FOR AGRICULTURAL ECONOMISTS

Farm Management

By Prof. John D. Black, Marion Clawson, Charles R. Sayre and Walter W. Wilcox. Pp. xii + 1073 + 62 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 27*s.* 6*d.* net.

FARM management as a subject of serious economic study has derived a great deal of stimulus from the United States, especially since the 'country-life movement' was set on foot there some forty years ago. The early workers in that field set out to study the whole social structure of the countryside; but a large part of their attention was necessarily directed to the purely business aspect of farming, and indeed the study of farm management has been in danger all too often of being regarded merely as a means of helping the individual farmer to make more profit. Anyone who is at all familiar with Prof. John D. Black's work on production economics, however, has learnt to expect a more comprehensive outlook, and in this imposing volume that expectation is not disappointed.

Apart from the four main parts of the book which deal, in no fewer than nine hundred pages, with systems of farming, principles and methods of analysis, problems of management, and management of types of farming, there are an introduction and a finale with chapters on such topics as the ends of farming, farming in a changing world, and agriculture in the national economy. These bear on the broader problems concerned with reconciling the interests of farmers with those of society as a whole, and embody much of the practical wisdom accumulated over many years by Prof. Black and his distinguished collaborators.

The student is made to see that modern agriculture does not stand in isolation, and that the management of a farm, if it is to be successful in the long run, should look beyond the immediate profit-and-loss account. This emphasis is to be welcomed in general, though some readers may consider, in this instance, that breadth has been secured at some sacrifice of depth. Certainly the British student, dependent as he largely is on American texts for the application of economic principles to farm management, will find the mass of descriptive material a little distracting, the more so as it relates almost entirely to American conditions. It is also unfortunate that some references to conditions in Great Britain are inconsistent and inaccurate. For example, it appears that if leasing arrangements such as prevail in England and Wales could be developed in the United States, there would be no serious objection to a large increase in tenancy in that country (p. 654); but this is a conclusion scarcely to be expected, perhaps, in view of the statement that in England "the landlord does practically nothing except to receive his rent and occasionally give his consent to having some new buildings or other improvements put on his farm, or possibly to having some timber cut" (p. 13).

Blemishes of this kind—there are a few others—are relatively unimportant against the authors' competent handling of their main project, which is to provide and expound methods for analysing the problems that develop on farms of varying complexity, and the principles which may be evoked for their solution. It is this aspect of the book, rather than the illustrative material, which will be found helpful and which deserves most attention, at any rate in Great Britain. R. N. DIXEY

THOMAS ALVA EDISON

The Diary and Sundry Observations of Thomas Alva Edison

Edited by Dagobert D. Runes. Pp. xii+247+5 plates. (New York: Philosophical Library, Inc., 1948.) 4.75 dollars.

DRIVEN by his deafness to read his way through the Detroit Public Library, Edison wrote long afterwards that he had found that almost any book would supply entertainment or instruction. This book, which contains selected excerpts from his writings, supplies the first in good measure and, for those who reflect on reading, more than a modicum of the second.

The pages from the diary which form the opening section of the book are full of whimsical humour which one would not have expected from a prodding experimenter who died with more than a thousand inventions to his credit. There is little reference in the book to Edison's experimental work, except for a short account of his early struggles to make a motion picture machine, carried out in a studio irreverently called the "Black Maria". But the background is there, revealed in the words that experiments in a laboratory consist mostly in finding out that something will not work. A realization of this, and of the fact that his own education was self-directed, gives added value to the pages on "Education and Work". In these pages he betrays a little impatience with the many for whom, with the passing of childhood, there comes the paralysis of curiosity and atrophy of the power to observe. They are so unlike himself. He remained curious and observant to the end. If a man more than seventy years of age cannot keep occupied, it is because there was lack of interest in a sufficient number of things when he was younger. He announced his intention of having a sign put up all over his plant reading, "There is no expedient to which a man will not resort to avoid the real labour of thinking".

With Edison, thinking led to an intense desire to work and to experiment. "No human being can live long without work", he writes in one of his sundry observations—the pleasure of idleness is one of the great superstitions of the human race.

Edison's observations on the possibilities of atomic energy, his somewhat casual remarks on the influences that make for peace or war and his comments on disarranged economic systems—all these make reading which is the more interesting because of all that has happened since the last of these lines was written. Reading the pages of this book, we feel that here was no recluse, no experimenter shut away in his laboratory from the rest of the world; here was one who was of the people, working for the people. "I consider," he writes, "that the first mission of the motion picture is to make people happy, the second—to educate, elevate and inspire."

This is a book to have on one's shelves and to dip into for five minutes when one feels depressed.

W. G. R.

UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THE University Grants Committee has always regarded itself fundamentally as a channel of communication between the State and the universities of Great Britain, and before the War this function was expressed mainly in the interpretation to the Government of the policies and financial needs of the universities. The increasing dependence of the universities on Government support makes it equally important that these policies and needs should also be interpreted to the general public. That function is admirably discharged by the present report*, which summarizes conveniently, with diagrams and comparative statistics, the changes that have occurred in what has probably been the most eventful twelve years in the history of most, if not all, of the universities of Great Britain. Although the new terms of reference of the Committee will make it increasingly concerned with the task of assisting the universities to plan their developments on lines that will meet as closely as possible the needs of the community, the new function will never diminish the importance of the old one of interpretation, both to the Government and to the community.

Before discussing post-war developments and problems, which occupy almost three-quarters of the report, the Committee deals briefly, in successive chapters, with the period 1935–39, the war years and with the revival of the universities after the War; and the narrative is illustrated by numerous appendixes which record changes in the membership of the Committee itself since 1936, the membership of the sub-committees constituted to deal with its new functions, university income and expenditure under main heads, capital benefactions and major additions to university buildings for 1946–47 in comparison with 1935–36, total numbers of students for 1938–39 and in the autumn term 1947 and of assisted students. Details are given of the arrangements for the deferment and call-up of university students, the call-up of university staffs for national service and of the war-time location of the University of London, its colleges and schools. Indeed, the report is a well-nigh indispensable reference work on university development in Britain, and the change in format will render its use for such purposes more generally convenient. Publication of the annual statistical volume of Returns from Universities and University Colleges in receipt of Treasury Grant, suspended since 1938–39, is to be resumed with the volume covering the academic year 1947–48.

The three changes recorded in the grant list since the last report in 1936 are the grant by the Privy Council to University College, Nottingham, of a charter of incorporation as a full university, the formal admission of the University Colleges of Leicester and Hull to the grant list, and approval of financial support for the establishment of a new University College at Stoke-on-Trent, subject to the grant of the necessary royal charter and arrangements for effective sponsorship by one or more universities. During the whole period covered by the report, the total income of the universities of Britain was more than doubled, rising from £6,060,995 in 1935–36 to £13,043,541 in 1946–47, the principal increases being £4,803,000 from Parliamentary grants, £1,052,000 from students' fees, £342,000 from endowments and £194,000 from local authorities. The increase in the Exchequer grant came mainly in 1945, and the proportion of the total income of the universities which is derived from the State has now risen from 34·3 per cent in 1935–36 to 52·7 per cent, and by 1951–52 may well be more than 60 per cent.

Before discussing the implications of this development, the report refers to non-recurrent grants and to the acceptance in principle, by the Chancellor of the Exchequer, of the Committee's estimate that the capital needs of the universities for the quinquennium 1947–52 would amount to some £40,000,000 for new building and £10,000,000 for site and equipment, of which by far the greater part would have to be found, if at all, by the Exchequer. At the same time, the Chancellor indicated that in view of unavoidable restrictions on new construction, it was unlikely that more than £20,000,000 of building work would be possible in the quinquennium, and subsequent deterioration in the building situation makes it very doubtful whether even this estimate can be fulfilled. Nevertheless, capital benefactions received by the universities during the twelve years under review amounted to £14,366,872, of which £5,996,636 was for the erection of new buildings or the acquisition of land and properties, £6,798,794 for endowments and £1,571,442 for the establishment of fellowships, scholarships and prizes. During the years 1935–36 to 1944–45, approximately £6,700,000 was expended by the universities on the erection of new buildings and purchase of properties, chiefly before the War. Total expenditure in 1946–47 was £12,951,071 as against £6,141,401 in 1935–36.

The quinquennial system of assessing grants was re-introduced in 1947, and by 1951–52 the contribution from the Exchequer to recurrent university purposes will have risen to about £13,000,000. The new and enlarged conception of the responsibility of the State in the field of university education has caused the Committee to reconsider seriously the principles which should govern the distribution among the universities of the money at its disposal. It considers its function to be not direction, but stimulation, co-ordination and advice; consequently, although the Committee has earmarked certain grants for special fields of study for reasons of national policy, it regards this device as unsuitable for permanent adoption because it impairs to some extent the universities' freedom of action. This principle of directing public money most freely into the channels in which it seems likely to produce the most fruitful results—a policy of helping those who help themselves—unlike the obvious criteria of need, is one that may favour the senior universities and those modern universities which have received the largest measure of support. Endowment income in 1946–47 still remained at 9·3 per cent over Great Britain as a whole but varied widely among the universities, averaging, for example, only 3·1 per cent in the University of Wales as against 10 per cent for those of Scotland.

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* University Development from 1935 to 1947. Being the Report of the University Grants Committee. Pp. 106. (London: H.M. Stationery Office, 1948.) 2*s*. net.

The report shows that the University Grants Committee is well aware of the difficulties which may arise in reconciling the claims of achievement with those of need, and it cites professional salaries as a pertinent example. The report details the reasons which led the Committee to recognize variations in such salaries as a permanent feature of university finance in Britain. The Committee finally decided to compromise on a plan which reduced the existing inequalities and recognized for all institutions a standard rate of professional salary, and assessed for each institution a sum which in the Committee's view might properly be expended in raising the salaries of some professors above the standard rate. While the factors to be taken into account in determining this assessment are indicated, the Committee did not seek to determine or to suggest the salary to be paid to a particular professor, and the arrangement is believed to have been accepted by the universities generally as a reasonable settlement.

That example itself indicates something of the character of the new and intricate relationship between the State and the universities which it is a main purpose of the report to illustrate. Moreover, the Committee regards as one of its most important functions that of devising appropriate means of reconciling the central planning of university developments with the maintenance of the essential academic freedoms. The need for some form of central planning is well recognized by the universities themselves, and the Committee believes that such planning is not irreconcilable with academic autonomy. It believes that the duty of ensuring that the large grants from the Exchequer are expended in the way best calculated to promote the public welfare can be discharged by the Committee in a relationship between the State and the universities which may properly be conceived as a form of partnership. Indeed, it suggests that the most serious threats to academic autonomy in Great Britain come rather from other external sources, such as benefactions accompanied by restrictive conditions, or from factors which in devious ways diminish the vigour of academic life.

The full extent of university dependence to-day on Government support is revealed not only in the financial sections of the report just outlined. It is further shown in the section of the report which deals with the number of students. After the fall in numbers during the War from 50,000 to 35,500 in 1943–44, largely in the faculty of arts, where the number of men students fell from nearly 15,000 to about 3,500, by October 1947 numbers had risen again to 77,000, and estimates received from the universities by the Committee indicate that by the end of ten years they expect to be able to deal with 88,000 students, or only 2,000 short of the total figure required to meet the recommendations of the Barlow Committee on Scientific Man-power. Expansion has been greater than expected in the Universities of Oxford and Cambridge and in many of the London colleges, but has been mainly in the provincial universities. Pre-war numbers in science and technology have been approximately doubled, but numbers in the faculties of arts have only risen by 50 per cent, and the Committee considers that it is unlikely that additional students in arts will be forthcoming to bring the number up to 10,000. For some years to come the proportion of students engaged in scientific and technological studies is likely to be higher than it was before the War.

The Committee suggests that this ratio should be kept in mind; but it is more concerned with the question of quality, both of students and of academic standards. Little direct evidence is yet available of the capacity of the schools to provide a largely increased supply of freshmen of the quality necessary for a university career, and the report emphasizes that more than a third of the students at present in the universities are receiving grants under the Further Education and Training Scheme. While this scheme is temporary, the percentage of full-time students receiving assistance in some form or other from public funds had risen in 1946–47 to 67·9 as compared with 41·1 in 1935–36, and the University Grants Committee believes that if the present number of students in the universities is to be maintained, still more if it is to be exceeded, subsidies on an unprecedented scale will be needed. The report briefly reviews the new problem of selection which these conditions present, starting with the assumption that the universities must not be deprived of an effective choice of their own entrants; its observations should be carefully noted in considering the recommendations of the Working Party on University Awards which have since been published.

Next, however, the report considers the bearing of the quality of the life and education which the universities are able to provide and the maintenance of university standards. The effect of the war years on those standards is reviewed in an early chapter; while there were certain imponderable gains, the balance was heavily on the debit side. Now the rapid increase in the number of students has imposed heavy strains on staff and students alike, which in some respects have involved serious deterioration in the standards of university life. The Committee is convinced that unless additional accommodation can be speedily provided, the present student numbers cannot be maintained without grave risk of impairing, not only academic standards which can be measured directly by examination results, but also those imponderable elements which form so valuable a part of university life. To quote the report:

"Unless there are considerable additions to accommodation, some universities will not be able to increase their staffs further. Moreover, a number of universities find themselves unable to make the fullest use of their existing staff owing to lack of accommodation for discussion groups and individual tuition. In some universities there is no room in Union or Library for a large proportion of the students; the present shortage of books adds further to the pressure on the libraries. At many universities there are, every day, long queues waiting for places in refectories which, even though enlarged considerably since the war, are quite inadequate for present numbers. A leisured university life with adequate opportunities for regular contacts between staff and students is rarely possible."

Elsewhere in the report the Committee states that there are no universities in Britain in which the provision of large new teaching blocks is not a pressing necessity, and that both teaching and research are seriously hampered by lack of space. Nevertheless, while stressing the vital importance of sufficient private rooms for staff and of taking a broad and imaginative view of the future in planning new libraries or extensions of the libraries, the Committee endorses the view that the further provision of halls of residence should be a primary object of university policy during the next decade, in spite of the difficulties of implementing such a policy at present. In many universities the greatest contribution which can be made to student life at this time is the increased provision of central amenities.

Apart from the physical aspects of university expansion and their bearing on the maintenance of university standards, the University Grants Committee is seriously concerned with the staff conditions. Reference has already been made to over-work and lack of leisure; and the point is reiterated in respect of the research worker, whose most elementary need, coming before even that of suitable equipment for research, is that of sufficient leisure from the pressure of other duties. In regard to research equipment, the Committee incidentally again refers to the importance of library expansion, and looks for some improvement in the facilities for the publication of learned works. One of the principal and most difficult problems confronting the universities is that of recruiting academic staff in sufficient numbers for the discharge of their wider responsibilities. Apart from the increase in the student population, in the spring of 1944 only 68 per cent of the holders of full-time teaching posts on normal establishments remained, 78 per cent of senior administrative and 57 per cent of library staffs. Altogether, some 1,380 members were absent in the Forces or on some form of national service. Furthermore, there is now a call for an increase in the ratio of staff to students, partly to permit students to receive much more individual tuition and partly to free more time for research. With the demand for specialized teachers and research workers arising out of the introduction of new subjects, the Committee estimates that the numbers of full-time staff should be increased during the decennium from the pre-war figure of 4,000 to not less than 10,000. By 1946–47 the number had risen to more than 5,500; but the maximum to be expected by the end of the quinquennium is estimated at 8,000. Questions of salary are discussed in some detail, and the report urges that all universities should review their administrative arrangements with the object of relieving their professors and heads of departments of any duties that do not necessarily demand their personal attention, and also that means should be found of enabling a larger proportion of lecturers to participate more directly in the administrative business of the university.

The report deals very briefly with such general academic problems as the place of research, curricula and teaching methods; but a section discusses a number of specific problems, mostly arising out of Government reports such as those of the Goodenough Committee, the Loveday Committee on Higher Agricultural Education, the Scarborough Committee and the Clapham Committee. The University Grants Committee has itself appointed a separate sub-committee to deal with technology, which will consider the recommendations of the Percy Report; but the work of this Committee falls outside the period of the present report. Finally, the extra-mural work of the universities is reviewed. The majority of the Committee believes that the universities are making and should continue increasingly to make a unique and indispensable contribution to adult education, but that their special function is to foster and intensify study by all means in their power, and to maintain a high standard of qualitative achievement among those engaged in it. The dissipation of resources should be avoided by wise discrimination.

PROBLEMS OF ORGANIC GROWTH

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ORGANIC growth is, without doubt, one of the basic biological phenomena. Physiology presents a wide realm of experiences concerning factors influencing growth; however, the phenomenon of growth itself remains, as yet, unexplained. Many growth formulæ have been proposed, but none has been generally accepted. Recent investigations, however, seem to provide a consistent theory leading to an explanation of growth in its general course as well as in its specific peculiarities, to quantitative laws allowing calculation and prediction, and towards a unification of the great physiological realms of metabolism, growth and form development[1].

Animal growth may be considered a result of the counteraction of synthesis and destruction: anabolism and catabolism of the building materials of the body. There is growth so long as building up prevails over breaking down; the organism becomes stationary if and when both processes are equal. This may be expressed in a general formula which contains no hypothetical elements:

$$\frac{dy}{dt} = \eta y^n - \varkappa y^m.$$

In words: the change in body weight y is given by the difference between synthesis and destruction of building materials; according to general physiological experience, these processes will be proportional to some powers, n, m, respectively, of the body weight; η and $\varkappa$ are constants of anabolism and catabolism.

To make use of this consideration, the processes involved must be defined. Catabolism is represented by the continuous loss of building material, and corresponds, in the higher animal, to what is called *Abnützungsquote*, or quota of wearing out (Rubner). Physiological experience shows that it is, to a good approximation, proportional to body-weight, so that the exponent m can be made equal to 1.

With respect to anabolism, a number of different cases can be distinguished. A survey of the types known hitherto is given in the accompanying table.

In micro-organisms[2], the character of the growth curves depends simply on the geometrical shape. In the case of spherical forms (yeast, micrococci) where the ratio of surface to volume decreases with increasing size, we find a decrease of growth-rates; on the other hand, rod-shaped forms (bacteria) which grow almost exclusively in length and where, therefore, the surface–volume ratio remains almost constant, show simple exponential growth. The fact that the surface where the intake of material takes place is a regulating factor of growth also in lower animals was demonstrated quantitatively in planarians by *measurements of the intestinal tract*[3]. The most interesting case is, however, growth in multicellular animals.

One of the classical problems of physiology is the dependence of basal metabolism upon body-size.

METABOLIC TYPES AND GROWTH TYPES

A. Anabolic processes depend on resorption (*resorbing surfaces*). (*a*) Micro-organisms: (1) Proportional growth: linear and volume growth curve as *B* I; spherical bacteria, yeast. (2) Growth almost exclusively in length: linear and volume growth curves exponential; rod-like bacteria. (*b*) Probably turbellarians.

B. Anabolic processes depend on respiration.

Metabolic type	Growth type	Examples
I. Respiration *surface proportional*	(*a*) Linear growth curve: attaining *without inflexion* a steady state. (*b*) Weight growth curve: *sigmoid*, attaining, with inflexion at *c.* 1/3 of final weight, a steady state	Lamellibranchs, fish, mammals
II. Respiration *weight proportional*	Linear and weight growth curves *exponential*, no steady state attained, but growth intercepted by metamorphosis or seasonal cycles	Insect larvæ, Orthoptera, Helicidæ
III. Respiration *intermediate between surface and weight proportionality*	(*a*) Linear growth curve: attaining *with inflexion* a steady state. (*b*) Weight growth curve: *sigmoid*, similar to I (*b*)	Planorbidæ

The fundamental formulation is the well-known *surface rule* of Rubner stating that in warm-blooded vertebrates basal metabolism, as measured by oxygen consumption, carbon dioxide or heat production, is a function not of weight but of surface. It is well known that this rule has been explained by Rubner through the exigencies of homeothermy. Later research[4], and especially a series of investigations carried through in our laboratory[5], has, however, demonstrated two important facts. First, the surface rule holds good also for many poikilothermous animals, vertebrates and invertebrates, so that the rule is of wide application; but the explanation given by Rubner is too restricted. On the other hand, there are also other modes of dependence of metabolism on body-size. Therefore, we arrived at the statement of *metabolic types* in respect of the relation between respiration and body-size.

Just as there are several metabolic types, there are also different *growth types*, distinguishing themselves by different growth-curves. We succeeded in establishing a connexion between metabolic types and growth types, providing an explanation and quantitative laws, and leading to the foundation of a comparative physiology of growth.

Investigation has shown that respiration is to be considered a limiting factor of anabolism of building materials. Inserting into the basic equation that value of n which is found experimentally for size-dependence of respiration, the growth laws of the organism in question follow automatically. It is possible, therefore, to *predict* the growth type of an animal from its metabolic type. This 'forecast' was confirmed in all cases hitherto investigated, sometimes leading to completely unexpected results. This system of growth laws has been applied to a considerable number of growth curves, including micro-organisms, tissue cultures, crustaceans, lamellibranchs, snails, hemimetabolic and holometabolic insects, fish, mammals, man, regenerative growth, etc., giving good numerical agreement in all well-investigated cases.

Since the constant $\varkappa$ of the growth equation represents the wearing-out quota, the values of $\varkappa$ as calculated from the growth curves should be identical with the values of protein catabolism, as measured by physiological experiment. In fact, the calculated values have been confirmed in a number of cases, including lamellibranchs, crustaceans, fish, man. This is, however, not true for small mammals: here the calculated values are considerably higher than those determined by the classical physiological methods, namely, determination of nitrogen excretion or protein loss in the starving animal. It was inferred, therefore, that the usual methods give values which are too low and that, in fact, protein metabolism goes on much faster than formerly assumed[6]. But this is just the conclusion which is reached by the modern method of isotope tracers[7]. It appears, therefore, that a combination of these two methods, namely, determination of protein metabolism by isotope tracers, and its calculation from the growth curves, should lead to important insights into this field of metabolism.

Very interesting are the connexions between *sex, metabolism*, and *growth*. Take, for example, a species showing remarkable sexual dimorphism in respect to growth and size, like the cyprinodont fish *Lebistes reticulatus*. Calculation of the growth curves shows that the ratio of the anabolic constants η in females and males is about $1 : 1\frac{1}{2}$. Theory demands that the same ratio should hold for respiration—and this is found to be the case.

Further application of the theory has been made in respect of environmental growth factors, as, for example, the *dependence of growth on temperature*, which partly coincides with Bergmann's rule in ecology. This leads to the conclusion that, while the growth curve is steeper at higher temperatures, a larger final size is reached at lower temperatures. This result corresponds to the observed data. The methods yielded by the theory can be applied also to the analysis of *geographical variation*, and should be useful for applied biology (fisheries, investigation of nutritional factors, etc.)[8].

So far, the quantitative analysis of growth and the establishment of growth laws consisted only in attempts to fit a number of growth curves to some formula. A rather scattered set of points as is given in observed growth data may very well be approximated, however, by quite different mathematical functions which, therefore, tell nothing about the underlying mechanism. Satisfactory approximation is a necessary, but by no means sufficient, condition, so that we may attach to a mathematical function a rational, as opposed to a merely descriptive, significance. The theory outlined above is of a different character; consequences can and have been deduced from it which can be tested by independent experiment; in some cases predictions have been later verified by experiment in a most surprising way.

The growth theory outlined here is part of a wider theoretical consideration, namely, the conception of the organism as an '*open system*', exchanging materials with its environment and approaching, in general, a steady state[9]. We cannot consider this point of view here, and may mention only that therefrom follows the *equifinality* of growth, that is, the fact that the same final state may be reached from different initial sizes (for example, individuals with different birth-weight in litters of different number) or after temporary suppression of growth (for example, by temporary undernutrition or vitamin deficiency). Also the *rule of constant cell size* is a consequence of the equifinality of growth. The concept of open systems has also been applied to the *biological elementary units*, viruses, genes, and chromosomes[10], and a physical model has been indicated[11]. According to these considerations, self-duplication in viruses and genes results from the fact that they are 'metabolizing aperiodical crystals'. At least in respect of chromosomes, this conception appears to be well founded since tracer investigation has shown that the nucleoproteins of the cell are continuously worn out and replaced[12].

Further investigations have been made in respect of *relative growth*. Allometry is a valuable tool in the investigation of metabolism[13]. In fact, the older disputes on the bearing of the surface rule have been caused largely by the fact that only arithmetical methods, and not allometric plots, have been applied. The latter has been done in more recent investigations, leading to our distinction of metabolic types, as mentioned above.

Another interesting phenomenon is the dependence of *physiological rhythms*, such as pulse and respiration frequency, on body-size[14]. According to the general principle that, roughly speaking, metabolism is relatively higher in small, as compared with big animals, pulse- and respiratory-rates decrease with increasing size. Quantitative analysis starting from the surface relation of basal metabolism, and taking into account the allometries of heart-size and beat-volume, leads to a rather remarkable result. The theoretical allometry of pulse-rate deduced from the factors mentioned corresponds astonishingly well with empirical data in a vast range of seven orders of magnitude, from the dwarf bat weighing 4 gm., with a pulse-rate of about 1,000 per min., to the elephant weighing 2,000 kgm., with a pulse-rate of 25 per min. Since in this deduction very crude approximations have been made, and anatomical, physiological and ecological peculiarities of the animals in question have been neglected, this result shows that simple size-dependence is the governing factor of pulse-rate. Similar conclusions apply to respiratory frequencies.

According to Huxley[15], we find in organisms and organs growth gradients which can be defined by the allometry constants of the different regions. On the other hand, there are, according to Child[16], 'physiological' gradients manifesting themselves in differences of susceptibility, metabolism, and morphogenetic activity. The connexion between growth gradients (Huxley) and physiological gradients (Child) is an important but hitherto uninvestigated problem. We have studied it in the classical object, namely, planarians, in order (1) to establish the relation between the different kinds of gradients; (2) to test Child's gradients in a quantitative way; and (3) to establish quantitative laws of toxic action[17].

The results have been rather fatal for Child's theory. In planarians, no connexion between growth and 'physiological' gradients can be found. Further, a quantitative analysis shows that even a primitive organism like a planarian is not characterized by a single axial gradient; but shows rather a bundle of axial gradations in respect of different physiological phenomena. These investigations have been continued in an extensive study of the toxic action of a group of substances of pharmacological interest, namely, the quinones. With respect to the gradient problem, different toxic actions have been distinguished and, as a new result, complete 'gradient inversion' was found, corresponding to definite molar concentrations.

Simultaneously, the *quantitative laws of toxic action* have been studied. The effect of concentration follows the equation $tc^a = b$ (t = time, c = concentration, a and b = constants), which is known also in other pharmacological reactions[18], and can be considered, from the physico-chemical point of view, as an adsorption isotherm, from the biological, as an application of allometry to pharmacological action.

Further, a *unification of the theory of growth in time and of relative growth* has been attempted[19]. These derivations lead to expressions which describe time-growth of organs without introducing new constants besides those of total growth and of allometry. Some consequences of this theory are that growth curves of linear dimensions should have no inflexion in organs of negative allometry and isometry, but should be sigmoid in the case of positive allometry; that in undernutrition organs of positive allometry should increase at the cost of others; that in starving animals organs showing positive allometry should decrease faster than those showing negative allometry or isometry, etc.

The conception of organic growth outlined here leads to important conclusions in respect of basic problems of evolution, such as orthogenesis, phylogenetical laws, bearing of selectionistic interpretations, role of hormonal changes, peculiarities of the descent of man, etc.[20]. Without entering into details, the relation to recent phylogenetic theory may be mentioned[21]. Thus, a vast range of problems, extending from physico-chemistry to physiology and morphological questions, is approached in this conception.

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AUREOMYCIN, A NEW ANTIBIOTIC

A VERY important series of sixteen papers on aureomycin has been published in the *Annals of the New York Academy of Sciences*, vol. 51, Art. 2, pp. 175–342 (November 30, 1948). These papers were the result of a conference on aureomycin held by the Division of Mycology of the Section of Biology, the New York Academy of Sciences, on July 21, 1948. They represent the work of forty-three investigators, sixteen of whom are on the scientific staff of the Lederle Laboratories Division, American Cyanamid Company, Pearl River, N.Y. The remainder are well known and independent biological and medical research workers in official laboratories, university medical schools and hospitals, all of whom were supplied with aureomycin by the Lederle Laboratories.

In the introductory paper, B. M. Duggar, of the Lederle Laboratories, traces the history of the discovery of the new antibiotic, and pays tribute to his late colleague, Dr. Y. SubbaRow, who directed the work until his death. Aureomycin, which has been obtained as a highly purified, crystalline, faintly golden-yellow substance, is a metabolic product of *Streptomyces aureofaciens*, a hitherto undescribed species of the Actinomycetes. Hence its name, and not, as a London evening newspaper has recently stated, "because it can be given by the mouth". It has clearly been made in considerable quantities—fermentation in tanks is mentioned—but few details are given of the methods used for the production and isolation of aureomycin, and chemists will look in vain for any information as to its chemical nature, except what can be gleaned from the fact that a hydrochloride and a borate are referred to. To avoid confusion, mention should be made of the fact that the trade mark 'Duomycin' has been given to aureomycin.

In vitro bacteriological studies of aureomycin, carried out in the Division of Penicillin Control and Immunology, Food and Drug Administration, Washington, in Johns Hopkins University School of Medicine and in Boston City Hospital and Harvard University Medical School, have established that aureomycin is effective against both Gram-negative and Gram-positive bacteria. Higher concentrations of the substance are required to produce bacteriostasis than are necessary with penicillin, being close to those required of streptomycin. Bacteria do not readily become resistant to it *in vitro*. It seems to be rather unstable in aqueous solution even at room temperature, though the dry solid material appears to be quite stable. An exhaustive study of the pharmacology of aureomycin, carried out in the Lederle Laboratories and at Johns Hopkins, established that it has a low toxicity and almost no side reactions, particularly in solutions of pH 8·5.

P. A. Little, in the Lederle Laboratories, found aureomycin effective in experimental infections in mice of *Eberthella typhosa*, *Erysipelothrix rhusiopathiæ*, the causative agent of swine erysipelas, and also in chickens infected with the causative agents of fowl cholera and fowl typhoid. On the other hand, workers at Johns Hopkins failed to protect mice with aureomycin administered orally in experimental infections with *Pneumococcus* type I or *K. pneumoniæ* A., although it did protect against *Streptococcus hemolyticus* beta, and Dr. Henry Welch and his colleagues at the Food and Drug Administration, Washington, conclude that "no outstanding usefulness for this antibiotic has been demonstrated by our animal investigations against the bacteria studied. The greatest promise for the drug lies in the treatment of certain viral and rickettsial diseases."

In spite of the not altogether favourable laboratory findings, clinical trials of aureomycin in human patients have given very promising results. About a hundred patients with a variety of bacterial infections have been treated with aureomycin by mouth at the Boston City Hospital. The results obtained in cases of gonorrhœa, while indicating that this treatment was effective in many cases, were inferior to those obtained with adequate amounts of penicillin. Four patients with pneumococcal pneumonia were successfully treated with aureomycin by mouth. In a number of urinary tract infections the results were favourable, and may be comparable with or possibly superior to those obtained from the use of streptomycin in similar cases. In contrast to streptomycin, there was no evidence of the development of bacterial resistance to aureomycin *in vivo*. Infections with *Proteus vulgaris* and *Pseudomonas aeruginosa* were not benefited by aureomycin. The results in the cases of typhoid fever and of severe *Salmonella* infections were equivocal. Workers in the George Washington University Medical Departments also failed to obtain any clinical or bacteriological response in four patients with typhoid fever. The results obtained by workers at Johns Hopkins in four cases of primary atypical pneumonia were very similar to those of the Boston workers. Eight cases of chronic urinary tract infection, which had not responded to penicillin, streptomycin or sulphonamide therapy, cleared promptly with aureomycin. A. E. Braley and M. Sanders, of the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, New York, report favourably on results with aureomycin borate used locally and aureomycin hydrochloride used intramuscularly in two hundred patients with a wide range of ocular infections, and found the antibiotic to be effective against some of the Gram-positive cocci and several Gram-negative bacilli. It was also found to be an effective therapeutic agent in the virus infections, inclusion conjunctivitis and herpes simplex of the cornea.

Indeed, even more striking than the antibacterial activities of aureomycin are its effects on viruses and rickettsiæ. S. C. Wong and H. R. Cox, of the Lederle Laboratories, have shown that although it has no apparent *in vitro* activity, it has marked therapeutic activity against the viruses of the psittacosis-lymphogranuloma group and rickettsiæ of the spotted fever, typhus fever, scrub typhus fever and *Q* fever groups in embryonated hens' eggs, mice and guinea pigs. On the other hand, it failed to show any therapeutic activity against a number of other viral infections, notably the *B* strain of influenza, canine distemper and the *MEF*-1 strain of poliomyelitis. Investigators in the rickettsial research laboratory of the University of Texas report favourable results in the treatment of guinea pigs infected with spotted fever and epidemic typhus. Clinical trials of aureomycin in human patients suffering from four different types of viral or rickettsial infections have given very promising results. A group of workers at Johns Hopkins and other investigators in the George Washington University Medical Departments obtained quite dramatic cures in a total of twenty-one cases of Rocky Mountain spotted fever treated with oral aureomycin. Workers in the Harlem Hospital and Columbia University, New York, treated a total of thirty-five cases of lymphogranuloma venereum, usually by intramuscular injection, and conclude from the excellent results they obtained that aureomycin is the treatment of choice in this virus infection. They also found that the ulcerative lesions in three patients with proved granuloma inguinale were healed by the use of this antibiotic. Finally, fifteen *Q* fever patients were treated with oral aureomycin by a group of Californian workers. In fourteen patients improvement occurred relatively promptly after commencement of the therapy, and the investigators conclude that oral aureomycin therapy offers considerable promise in the treatment of this fever.

Although it may be unwise to do so, one is tempted to try to assess the probable future importance of aureomycin in relation to three other antibiotics of proved clinical importance, namely, penicillin, streptomycin and chloromycetin from *Streptomyces venezuelæ*. In the treatment of most Gram-positive bacterial infections, the supreme position of penicillin remains unchallenged. Streptomycin appears to hold a similar though less exalted position in the treatment of many tubercular infections; but it seems probable that aureomycin may displace streptomycin in the treatment of many Gram-negative infections, particularly of the urinary tract, because of the unquestioned advantage it possesses that bacteria do not become resistant to it *in vivo* as they often do to streptomycin. In the treatment of viral and rickettsial diseases, both chloromycetin and aureomycin offer considerable grounds for hope in infections which have so far proved very resistant to chemotherapeutic agents. Whether these two antibiotics will prove to be competitive with, or supplementary to, each other only the future can tell. In the meantime, British investigators will wish to congratulate their American colleagues in the Lederle Laboratories on a very noteworthy achievement. HAROLD RAISTRICK

POST-GLACIAL CLIMATIC CHANGE

A WELL-ATTENDED joint meeting of the Royal Meteorological and Royal Astronomical Societies on December 15 discussed recent work on changes of climate since the Ice Age. The discussion was opened by Mr. F. Hoyle, who said that any persistent change in the temperature of the earth's surface must depend ultimately on radiation from the sun. Without some external cause, solar radiation would not change appreciably in many millions of years, neither would the mean distance of the earth from the sun. But the sun travels through a gaseous medium which is aggregated locally into clouds, and in passing through such a cloud it would sweep up a number of particles. The kinetic energy of these, falling into the sun, is converted into heat, which might increase total solar radiation by as much as ten per cent. All this excess energy appears in the ultra-violet part of the spectrum, but as the latter normally forms only one ten-thousandth part of the solar radiation, passage through a cloud would magnify the ultra-violet many times. This radiation is absorbed in the higher levels of the atmosphere and might alter its whole behaviour, causing great changes of climate.

The strongest evidence for post-glacial changes of climate is biological, and Prof. H. Godwin described the analysis of frequencies of pollen grains. These show the successive incoming of birch, pine and hazel, elm, oak, lime and alder, indicating a progressive amelioration of climate. The sudden expansion of alder and lime about 6000 B.C. marked the beginning of the Post-glacial Climatic Optimum, a warm period which continued until about 3000 B.C., after which the climate again deteriorated. There was a rather sudden worsening about 500 B.C., with flooding horizons and other evidence of increased rainfall. But the interpretation of biological evidence is sometimes difficult. It depends mostly on the present range of the species; but the regional range may be confused with what Prof. Godwin termed the 'microclimatic range', which allowed of local occurrences in exceptionally favoured spots outside the main range.

Prof. Godwin gave an interesting example of a new technique in the analysis of floras, in the climatic control of holly, ivy and mistletoe. A number of meteorological stations are selected and the performance of nearby plants noted—whether they bear ripe fruit regularly, occasionally or never, or whether the plant is not found in the district. These are plotted on diagrams against the mean temperatures of the warmest and coldest months. In this way the 'thermosphere' of each species is defined. Holly and ivy are controlled by the winter temperature, mistletoe by the summer temperature. Prof. Godwin illustrated a region in which the two former are at present flourishing, while mistletoe does not ripen its fruits (mild winters, cool summers). In the Sub-boreal, ivy and mistletoe flourished but not holly (cold winters, hot summers). During the Climatic Optimum, however, all three plants ripened their fruits, indicating mild winters and warm summers.

Climatic changes in the historic period were described by Prof. Gordon Manley, who compared long instrumental records of temperature with advances and retreats of glaciers. The greatest post-glacial expansion of glaciers began in Scandinavia so late as 1750, in the Alps about 1550 and in Iceland probably as early as 1350. Glaciers are now everywhere in rapid retreat, and in Norway archæological remains have been uncovered dating from 1300. Long records of temperature have been carried well back into the eighteenth century at Stockholm, in Holland, and by Prof. Gordon Manley himself in Lancashire. There are difficulties of exposure and of local change of climate due to urbanization, but the general agreement is sufficient to show that the major oscillations are real. The principal feature has been a rise of winter temperature while the summer temperature has maintained a generally constant level; the annual range has everywhere decreased. The temperature records fit in very well with the records of glaciers; in particular, the chilly springs about 1740, which were general and in places catastrophic, decreased the ablation period for glaciers and were followed by glacial advances.

Prof. Gordon Manley then discussed possible causes. Dr. Ångstrom considered that periods of maritime climate were due to increases of the atmospheric circulation, but this only carries the problem back one stage. Moreover, the great fall of temperature about 500 B.C. requires some other factor, and this may be found in the spread of Arctic ice and melt-water. Low spring temperatures result from the frequent inflow of polar maritime air; mild winters with little frost are associated with maritime tropical air, and resemble the conditions in the

Climatic Optimum. It is probable that the changes from year to year due to changes in the circulation are of the same order of magnitude as the average changes between the different post-glacial periods, and the problem now becomes that of finding out why such conditions persisted through decades or centuries instead of only for a year or two at a time.

Dr. C. E. P. Brooks said that the extreme climate, with cold winters and hot summers, which followed the retreat of the ice, could reasonably be put down to the combination of a greater inclination of the earth's axis and the fact that the earth was only just passing out of the condition in which the northern hemisphere was in aphelion in winter. The Climatic Optimum, which was not only mild but also seems to have been on the whole a period of greater rainfall than the present, required some other explanation. The highest temperatures preceded the maximum submergence of the Litorina Sea in Scandinavia; moreover, such a local cause could not explain a change over the whole hemisphere. He thought that the most likely cause was an increase of solar radiation, and he asked whether this could have been brought about by a cosmic cloud. Later, Prof. E. A. Milne and Mr. Hoyle replied that there could not be clouds small enough to cause changes of only a few hundred years, and, though there may be changes of density within a cloud, astronomical theory cannot be tied up with recent climatic changes.

The period which comes at the end of the Climatic Optimum had a peculiar, very extreme climate. Botanists thought that there were alternating contrasted periods of heavy rainfall and drought; at the end, from about 800 or 700 B.C. until 500 B.C., was a 'dry heat wave', after which the climate became very wet and stormy. Such oscillations must be due to changes in the frequency and tracks of depressions, and these might result either from changes of solar activity as indicated by the frequency of sunspots and auroras, or from changes in the outflow of Arctic ice into the Atlantic. The curve of solar activity cannot be traced with any reliability before A.D. 1000, and though there is some resemblance to the variations of rainfall, this is not very close. Dr. Brooks then referred to a theory put forward by O. Pettersson in 1914 that changes of climate since about 3500 B.C. were due to variations in the tides, and particularly in the submarine tides at the boundary of the Atlantic and Arctic. Tidal maxima occurred about 3500 B.C., 1900 B.C., 250 B.C. and A.D. 1433, and about these dates the Arctic ice-cap would tend to be broken up and much ice drift out into the Atlantic. These maxima agreed very well with the periods of maximum rainfall in the northern hemisphere, derived from peat bogs, levels of lakes and rivers, migrations and documentary evidence. He thought that after the Climatic Optimum, before the Arctic ice-cap had firmly re-established itself, the changes of climate resulting from changes in the ice would be very large. With regard to minor oscillations of the order of a decade, he asked if they must have a cause. Could they not just happen, as variations happen in any random series of events?

Mr. D. J. Schove described recent documentary evidence from China, which pointed to great droughts in the third and fourth centuries A.D., floods in the eleventh and drought in the twelfth. He remarked that in Europe the first half of the sixteenth century was very similar to the first half of the twentieth, but about 1540 there was a sudden change to good summers and cold winters. Other speakers mentioned the possibility of causes such as the disappearance of seaweed in the Sargasso Sea and the occurrence of great volcanic activity, for example, in the Rift Valley of Africa. Prof. P. A. Sheppard remarked on the tendency to look for the causes of climatic change everywhere but in the atmosphere, which goes through quite considerable swings not inspired directly by the sun. Although these are generally short-lived, they may be slowed down by the influence of a snow-cover, which may cause long-period variations.

The discussion showed that the various lines of attack on the problem of climatic change are beginning to converge. Our knowledge of the succession of events is becoming very detailed, and the meteorology of climatic change is becoming clearer; but there is not yet any general agreement on the causes. Variations of solar radiation are fundamental, however, and the problem is not likely to be finally solved until these have, in one way or another, been elucidated.

OBITUARIES

Prof. J. H. Maclagan Wedderburn, F.R.S.

Joseph Henry Maclagan Wedderburn, emeritus professor of mathematics, Princeton University, died at his home in Princeton on October 9, 1948, at the age of sixty-six.

Prof. Wedderburn was born at Forfar in 1882 and educated in Edinburgh, where he graduated in 1903. While still an undergraduate, he was elected in 1902 to membership of the Edinburgh Mathematical Society, and soon afterwards, in 1903, to fellowship of the Royal Society of Edinburgh, which later, in 1921, awarded him the Makdougall-Brisbane Prize for his researches into hypercomplex numbers. He obtained the degree of D.Sc. of the University of Edinburgh in 1908. During 1905–9 he was assistant to Prof. George Chrystal, and is remembered as introducing the course in general analysis; but the natural bent of his mind was towards abstract algebra. This interest had been fostered by postgraduate residence in Leipzig, Berlin and Chicago, especially the last, where his mentors, E. H. Moore and L. E. Dickson, were to him a help and permanent inspiration. His first papers on modern algebra were published in 1905 in the *Transactions of the American Mathematical Society*. At the age of twenty-five he had acquired a mastery of the structure of algebras and had made a classical contribution to the theory of semi-simple algebras.

In 1909 Wedderburn left Edinburgh and joined the faculty of mathematics at Princeton University. The First World War interrupted his career for five years. He served in the Seaforth Highlanders, later in command of an observation group in the Royal Engineers, and was mentioned in dispatches. It is characteristic of his unassuming disposition that he had enlisted as a private.

Returning to Princeton, Wedderburn was assistant professor of mathematics during 1921–23, then associate professor until 1928, and finally full professor until he retired in 1945. In 1933 he was elected a fellow of the Royal Society. He never married, and was accustomed to spend his vacations in a remote farm in the Adirondacks.

Wedderburn was not a prolific writer, committing himself to publication only when he had something of essential significance to impart. This gives an impression of reserve and distinction to his work. The present eminence of American mathematicians in algebra owes not a little to his pioneering, to his excellent teaching and to his editorship-in-chief, for nearly twenty years, of the *Annals of Mathematics*, which in 1911 became the charge of the Department of Mathematics at Princeton, and steadily rose to its present distinguished position among the mathematical periodicals of the world. The volume of the *Annals* published in 1946 was in effect a *Festschrift* dedicated to him. This may be taken as an indication of the respect in which he was held, not only by mathematicians in the United States, but also by mathematicians everywhere. A. C. AITKEN

Dr. George Scott Robertson

GEORGE SCOTT ROBERTSON, permanent secretary of the Ministry of Agriculture, Northern Ireland, died on December 22.

Although his family had been closely associated with Aberdeen for a long period, he was born in 1893 in Middlesbrough, where his father, William Robertson, was for many years editor of the *North Eastern Daily Gazette*. Robertson graduated B.Sc. (Agr.) at Armstrong College, University of Durham, and spent two years there as lecturer in agricultural chemistry. In 1914 he became head of the Chemistry Department of the East Anglian Institute of Agriculture, and in 1920 lecturer in agricultural chemistry at Queen's University, Belfast. A year after going to Northern Ireland he received, for his work on basic slag and rock phosphates, the first D.Sc. degree ever conferred by the University of Durham in its Faculty of Agriculture.

When the Government of Northern Ireland was formed, Robertson's inspiration and drive resulted in the creation of the Faculty of Agriculture in Queen's University, Belfast, which developed in the closest association with the Ministry of Agriculture, Northern Ireland. By 1924 he was professor of agricultural chemistry and dean of the Faculty, as well as senior research officer of the Ministry of Agriculture. By 1933 he became permanent secretary of this Ministry, and for fifteen years directed the work of his Department in peace and war, and saw it grow from a comparatively small organisation into one which to-day touches almost every phase of the life of agricultural Ulster.

Robertson's reputation extended far beyond Northern Ireland. He served with distinction on the Empire Marketing Board, the Imperial Agricultural Bureau, the Food Investigation Board of the Department of Scientific and Industrial Research and the Agricultural Research Council. For many years he was closely identified with the work of Section M (Agriculture) of the British Association; owing to illness, his presidential address at the Brighton meeting last September was read by a colleague.

In 1947 a striking tribute was paid to him when he was invited to become the first director of the new Agricultural Production Division of the Food and Agriculture Organisation of the United Nations. Robertson was absent from Northern Ireland on this work during the greater part of 1947, and when he returned to Belfast it was evident that his health had been impaired by the heavy work he had undertaken—a task superimposed on many years of active endeavour.

Robertson's great services to agriculture in Northern Ireland and in the furtherance of agricultural science throughout the world generally were recognized by Queen's University last year, when the degree of LL.D. (*honoris causa*) was conferred upon him.

His publications include "Basic Slags and Rock Phosphates" (1922) and many other contributions to scientific journals. His main research work was concerned with phosphatic fertilizers in Essex and later in Northern Ireland—investigations which were of outstanding importance and are quoted to-day as classics in their sphere—and pioneer work in collaboration with Sir John Boyd Orr on the mineral requirements of farm livestock.

Robertson was respected for his outstanding ability and qualifications as a leader by his colleagues. He was held in deep and abiding regard as a friend by very many who will mourn his loss.

J. HOUSTON

M. Louis Rapkine

LOUIS RAPKINE was born at Chichenich in White Russia on July 14, 1904. His father, who was a tailor, migrated to Paris in 1911, taking his family with him, and after a difficult year, went to Montreal, where he worked in a factory. Rapkine grew up as a Canadian citizen. He gained his school education by scholarships. He was a good athlete, excelling in netball and swimming. He spent three years at McGill University, supporting himself by working in the summer vacations. When he was twenty, he left Canada to pursue scientific research in France.

Rapkine's scientific training was unusual, for he never took a doctorate. He worked in the laboratories of Caullery and Fauré-Fremiet, and in Wurmser's laboratory at the Institute of Physico-Chemical Biology. In France, at first, he had very meagre means of support. He kept himself by hawking in the countryside and selling boots at country fairs. Sometimes he starved, and was reduced to eating glucose from laboratory bottles.

In spite of these conditions, Rapkine did important work before he was twenty-one. With various collaborators, he published in 1925 extensive observations on the hydrogen ion concentration in egg-cells by the micro-injection of dissolved indicators. He investigated the oxidation-reduction potentials of the nucleus and cytoplasm, and showed that the old idea that the nucleus was a special centre of oxidation was without foundation. His situation was relieved by the award of a Rockefeller fellowship in 1926. He found that the respiratory quotient for the echinoderm egg at four hours after fertilization was extremely high, and then slowed down. He concluded, contrary to Warburg and Shearer, that in the initial period oxidation-reduction was concerned with synthesis, and independent of respiratory processes. He published a monograph in 1928 on the energetics of the development of the egg. He pointed out that the developing organism may have at its disposal sources of energy other than complete combustion to carbon dioxide and water, and remarked that peak-protein catabolism coincides precisely with the stage of development at which chick embryos best provide plasma for tissue culture. In the same year, he was appointed assistant at the Institute of Physico-Chemical Biology, and afterwards received appointments from the Centre National de la Recherche Scientifique.

Rapkine found that the fertilization of sea-urchin eggs was connected with changes in sulphydryl groups. Multiplication of cells depended on their presence. He was thus led to the study of enzymes. He found that the oxidation of sulphydryl groups was much more rapid when the enzymes were separated from their co-enzymes. He supposed that this was because the co-enzyme was attached to the enzyme in the region of sulphydryl groups, disturbing the access of oxidizing molecules.

The late Sir Frederick Gowland Hopkins had arrived at similar results in part of the sulphydryl work. When he heard of Rapkine's work, he withdrew, so that the younger man should be assured of priority.

By 1939, after a hard struggle, Rapkine was scientifically established. He was thirty-five years old, and had arrived at about the same stage as Hopkins at a similar age. There were resemblances between them in unorthodoxy of career and quality of mind. He became a French citizen just before the Second World War. At the outbreak he was mobilized and sent to London to the office of the French coal-importing organisation, where he compiled statistics.

When France was invaded in 1940, Rapkine set himself to save French scientific workers from the enemy. He compiled a list of fifty-seven, whom he endeavoured to rescue. Without any authority other than his own character, he secured the support of the highest scientific and political personalities in London and Washington. He organised the escape of about forty leading scientific workers from France to the United States. He obtained posts for them, and even got their hospital bills paid.

In 1943 Rapkine negotiated an agreement with the British authorities for the establishment of a French Scientific Mission. He brought the group of French scientific workers in the United States to London to be its staff. This enabled France to receive during and after the liberation much new scientific knowledge and experience. As a consequence, a permanent secretary for Franco-British scientific exchanges was attached to the French Embassy in London. In recognition of this work, he was appointed a Chevalier of the Legion of Honour. Rapkine's last act as an administrator was to negotiate a donation of 350,000 dollars from the Rockefeller Foundation for the assistance of research in France.

Rapkine had revealed unique powers of leadership. Nevertheless, he hurried back to personal research. The Pasteur Institute created a Department of Cell Chemistry for him, and he threw himself passionately into its development. He aimed at the solution of the mechanism of enzyme action. He believed that a single enzyme might be capable not only of one specification, but of many. He was organising a co-ordinated attack on this problem.

Rapkine's premature death, on December 13, is a disaster not only to his relatives and friends, but also to science, and to France. He had an extraordinary combination of moral strength, personal charm and intelligence, kindness, generosity and selflessness, besides practical and scientific ability. Many of those who knew him well regarded him as the finest man of his generation. His wife, who assisted him in his scientific work, and his daughter survive him. J. G. Crowther

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NEWS and VIEWS

Recent Medal Awards: Geological Society of London

The Council of the Geological Society has announced the following awards: Wollaston Medal, to Dr. Robert Broom, in recognition of his researches in the field of vertebrate palæontology, especially in the study of the evolution of the reptiles and of the anthropoid apes and man; Murchison Medal, to Dr. E. M. Anderson, in recognition of his investigations of the igneous, metamorphic and stratigraphical geology of Scotland, and of his many original contributions in the field of geophysics; Lyell Medal, to Dr. W. J. Arkell, for his geological researches, especially on the stratigraphy, structure and palæontology of the Jurassic rocks of Great Britain; Bigsby Medal, to Prof. W. Q. Kennedy, in recognition of his petrological researches and for his outstanding contributions in the field of tectonic geology; Wollaston Fund, to Mr. E. C. Martin, for his work on the Chalk Tertiary and Pleistocene succession in Sussex, and his valuable contribution to geological science as treasurer of the Geologists' Association for thirteen years, including the war years; Murchison Fund, to Dr. S. O. Agrell, for his work on the adinoles of Dinas Head, Cornwall, and his mineralogical observations on some basic open-hearth slags; a moiety of the Lyell Fund, to Dr. W. D. Evans, for his work on the Ordovician rocks of north Pembrokeshire, on air-borne dusts in collieries and on the Midland iron-ore of coalfields; another moiety of the Lyell Fund, to Dr. P. E. Kent, for his geological investigations in East Africa and in the United Kingdom.

Royal Astronomical Society

The Council of the Royal Astronomical Society has made the following awards: Gold Medal to Prof. Sydney Chapman, Sedleian professor of natural philosophy in the University of Oxford, for his contributions to geophysics and solar physics, and particularly to the theory of geomagnetic phenomena; Jackson-Gwilt Medal and Gift to Mr. Algernon Montague Newbegin, for his observations of solar prominences and sunspots during the past forty years.

Institution of Mechanical Engineers

The James Watt International Medal of the Institution of Mechanical Engineers has been awarded to Dr. Fredrik Ljungström, of Sweden, for his outstanding contributions to the development of mechanical engineering, the most notable of which are the air preheater which bears his name and the steam turbine developed jointly with his brother, the late Birger Ljungström. The Medal is awarded every two years to an engineer who has achieved world-wide eminence in some branch of mechanical engineering.

Engineering at University College, London : Prof. G. T. R. Hill

PROF. G. T. R. HILL retired at the beginning of the present academic session from the Kennedy chair of mechanical engineering at University College, University of London, which he had held since 1934. During the First World War, Prof. Hill was engaged in aerodynamic research and acted as observer during flight trials on new and experimental types of aeroplanes. Awarded a commission in the Royal Flying Corps in 1916, he was posted overseas to France, was awarded the Military Cross and promoted to the rank of captain. In 1917 he was posted as a flight commander to an experimental station of the Royal Aircraft Factory. In 1918 he was posted to the Air Ministry as deputy head of the section responsible for dynamics research. After demobilization in 1919, he worked with Messrs. Handley Page as chief test pilot and experimental engineer, until in 1922 he was awarded a senior studentship by the Commissioners of the 1851 Exhibition. Later, with the aid of a grant from the Aeronautical Research Committee, he completed the design of the tail-less aeroplane (Pterodactyl). This work was taken over in 1926 by the Westland Aircraft Works, whose staff he then joined, and thereafter with the aid of experimental contracts by the Air Ministry he developed a type of Pterodactyl for war purposes.

Prof. Hill's work has covered a wide field in applied science, involving problems in ballistics, hydraulics, optics, electricity, as well as metallurgy and mechanical engineering. As a lecturer at engineering societies, schools, Royal Air Force units and other bodies throughout Britain, Prof. Hill is known for the ever delightful lucidity by which he illustrates intricate problems connected with his special subject. In college he was a delightful colleague, always maintaining close interest in matters affecting staff and students, and his outstanding work in the University of London Air Squadron greatly helped to maintain contacts and the thrill of his earlier years. His associates throughout University College will miss his pleasing personality.

Northern Ireland Ministry of Agriculture : Mr. D. A. E. Harkness, C.B.E.

MR. D. A. E. HARKNESS, senior assistant secretary in the Northern Ireland Ministry of Agriculture, has been appointed secretary in succession to the late Dr. G. Scott Robertson. Mr. Harkness was acting secretary in the Ministry when Dr. Robertson was given leave to become the first director of agricultural production and research under the Food and Agriculture Organisation. He graduated in the University of Glasgow and became assistant to the professor of economics at Queen's University, Belfast, before joining the Northern Ireland Ministry of Agriculture in 1924 as chief of the Statistics and Intelligence Branch. In 1926 Mr. Harkness was appointed lecturer in agricultural economics at the Queen's University, a position which he held until shortly after his appointment as assistant secretary in the Ministry in 1936. He became senior assistant secretary in 1939.

Committee on Interrelations of Pleistocene Research

IN June 1947 a new committee, known as the Committee on Interrelations of Pleistocene Research, was set up under the Division of Geology and Geography of the National Research Council, Washington, D.C. This Committee, which stresses the fact that research in this significant field involves numerous disciplines, is under the chairmanship of Dr. Richard F. Flint, professor of geology, Yale University. Its objectives are : (*a*) to study the field of Pleistocene studies and to survey research in progress ; (*b*) to prepare a report on the various lines of research now being carried out ; and (*c*) to suggest problems that should be attacked, with special emphasis on those involving two or more disciplines. The list of members and the fields covered by each provide an indication of the effort being made by this group to achieve broad representation. The members are : Dr. Edward S. Deevey, jun., lecturer in biology, Yale University (biogeography) ; Dr. Loren C. Eiseley, professor of anthropology, University of Pennsylvania (anthropology and New World archæology) ; Dr. Claude W. Hibbard, associate curator of vertebrates, Museum of Palæontology, University of Michigan (vertebrate palæontology) ; Prof. Chauncey D. Holmes, professor of geology, University of Missouri (glacial erosion and sedimentation) ; Dr. Helmut E. Lansberg, deputy director, Committee on Geophysical Sciences, Joint Research and Development Board, Washington, D.C. (meteorology and climatology) ; Dr. Hallam L. Movius, jun., curator of palæolithic archæology, Peabody Museum, Harvard University (Old World archæology) ; Dr. Fred B. Phleger, jun., asst. prof. of geology, Amherst College (oceanography and sea-floor geology) ; Dr. Louis L. Ray, United States Geological Survey (glacial stratigraphy and alpine glacial geology) ; Dr. H. T. U. Smith, associate professor of geology, University of Kansas (eolian features, frozen ground and stream terraces) ; Dr. James Thorp, principal soil scientist, United States Dept. of Agriculture (soil science). This group is especially anxious to correspond and exchange reprints with foreign workers interested in various aspects of the Pleistocene, and to obtain information concerning research now in progress.

On April 5 and 6, 1948, the Committee held its first meeting, at which were discussed several measures looking towards closer co-operation among those working in the various fields that deal with the Pleistocene. It was decided to publish a series of articles in 1949 covering some of the major problems, which may be assembled in a single volume for distribution by the Division of Geology and Geography of the National Research Council. Plans were made to compile a map showing the distribution of the loess and wind-blown deposits of North America. It is felt that the ground-work has been laid for breaking down certain of the arbitrary divisions between the various disciplines, the existence of which has so badly hampered Pleistocene research up to the present (see also p. 186 of this issue).

International Book Token Scheme

A SCHEME has been devised by Unesco to overcome foreign-exchange difficulties and so enable educational and scientific institutions in 'soft' currency countries to buy publications from 'hard' currency countries. Purchases will be made in the national currency of the countries concerned, and Unesco will supply the necessary dollars. The plan will operate for an experimental period of one year and is limited to 150,000 dollars worth of book coupons, which will be shared by eleven countries, including Great Britain. If it is successful, however, the scheme may be expanded to include all member

States of Unesco. The coupons may be used to buy books on education, science and culture, the importation of which is prohibited by importing laws. They can also be used for subscriptions to periodicals, for the purchase of individual volumes or issues and for the payment of photo copies. The coupons will be available in denominations ranging from 25 cents to 10 dollars. Other countries where the coupons will be on sale are: China, Czechoslovakia, France, India and Poland. In addition, a limited free distribution, financed by Unesco, will be made in Austria, China, Czechoslovakia, Greece, Hungary, Italy, the Philippines and Poland. The coupons of each participating country will be handled by its own national distributing body, and in Great Britain this function is being undertaken by Book Tokens, Ltd., 28/30 Little Russell Street, London, W.C.1, from whom all particulars may be obtained. It is pointed out that as the amount of dollars available is limited, coupons will be allocated on a priority basis, and the needs of educational, scientific and cultural institutions serving a large public will be given first consideration.

Northern Advisory Council for Further Education

In March and April of 1947, the Minister of Education issued directions to local education authorities to prepare and submit schemes for further education and plans for county colleges. In Circular 133, containing directions for further education, the Minister reminded local education authorities that they are required when preparing their schemes to "have regard to facilities provided by other bodies and to consult such bodies and local education authorities for adjacent areas". The procedure for the consultations referred to in Circular 133 was discussed by the Northern Advisory Council for Further Education at its meeting in October 1947, when it was decided that the first step should be the preparation of an agreed draft by a committee consisting of the 'chief education officers' of the constituent authorities. Its report has now been prepared and was approved by the Council in November 1948. Adult education, county colleges, community centres and other kinds of further education were considered to lie outside the scope of the Committee, and its deliberations were confined to technical, commercial and art education as provided in the main colleges. Starting from the broad principle that each authority should be free to provide for its own residents up to the national certificate stage, provided that numbers justified this measure, the Committee has worked out a detailed programme in which technical education in the north-east area could function as an integrated regional scheme. Implementation of the recommendations in this report would do much to provide Great Britain with adequate numbers of the technically trained persons who are so urgently required. Copies of the report may be obtained from 43 Eldon Place, Barras Bridge, Newcastle-upon-Tyne, 1.

Magnetic Field of the Sun

A recent paper by Prof. S. Chapman (*Mon. Not. Roy. Astro. Soc.*, 108, No. 3; 1948), with the title "Solar Magnetism and the Suggested Fundamental Magnetization by Rotation", deals with the difficulties in accepting the 'fundamental' hypothesis, recently revised by Blackett. According to this hypothesis, the general magnetic fields of the earth, the sun and of certain stars introduce a new fundamental property of rotating bodies which can be expressed by the formula $P/W = \beta G^{1/2}/2c$, P being the axial component of the dipole magnetic moment, W the angular momentum, G the constant of gravitation, c the speed of light, and β a factor of the order unity (for the earth it is 0·3). It was pointed out by Bullard that the fundamental hypothesis seems to imply a downward decrease of intensity of the geomagnetic field within the earth, and measurements since made in South Africa and in England provisionally support the hypothesis (see *Nature*, **160**, 746; 1947; **161**, 462; 1948). Chapman develops the consequences of the hypothesis—in particular as to the nature of the internal fields of the earth and sun—basing his calculation on the density distribution given by Blanch, Lowan, Marshak and Bethe for the point convective model of the sun, and taking into account a non-uniform distribution of the angular velocity approximating to that given by Schwarzschild. The corresponding moment of inertia and angular momentum of the sun are calculated, and β is estimated to be 2 if the sun's polar magnetic intensity is 50 gauss; but accepting Thiessen's recent value of 10 gauss, or less, β cannot exceed 0·4, which is close to 0·3, the value of β for the earth. The inferred intensity at the centre is a few thousand gauss, similar to that of sunspot magnetic fields. The fundamental theory seems incapable of explaining the existence of the intense sunspot magnetic field, and this weakens the case for postulating a new fundamental property of matter to explain the general magnetic field. It is admitted, however, that it is remarkable, and may be profoundly significant, that the ratios of the values of P, extending over a considerable range, for the earth, the sun, and certain stars, to the associated values of W, differ by less than one factor of ten.

Suggestions for Science Teachers in Devastated Countries

Unesco has recently published an illustrated booklet showing how teachers lacking elementary scientific equipment can make apparatus from simple everyday materials. The booklet has been prepared by Mr. J. P. Stephenson, science master at the City of London School, who first explains how science teaching can be commenced without the use of apparatus and then shows how equipment for experiments in astronomy, meteorology, heat, light, magnetism, electricity, chemistry and biology can be improvised from materials such as wood, glass-tube, wire, nails, bottles and other household articles.

A note is also included on the use of visual aids in science teaching together with a description of recent laboratory materials, such as plastics and alloys, and a section on laboratory receipts, charts and logarithm tables. The booklet is being distributed free by Unesco to schools in Greece, Poland, Czechoslovakia, Austria, Hungary, Italy, China and the Philippines, with the hope that it may lead to further improvisation in apparatus for elementary science teaching. It should be interesting later to see what influence this booklet has on the teaching of science in the recipient countries.

Paper Supplies for Books

In a written reply to a question in the House of Commons, the President of the Board of Trade states that from March 6 the licensing arrangements for paper will be considerably simplified. As a result, paper for books, stationery, boxes, cartons and many minor uses should be freely available without individual licences or quotas up to the full extent of the limits set by the supply position. Bulk licences will be given to paper makers and importers authorizing them to deliver or convert any paper produced or imported by them, with certain specific exceptions, which include newsprint, insulating cable paper, certain classes of paper used for packaging, etc. The use of paper for newspapers and periodicals will still be restricted by the provisions of the Paper Control Orders. The improvement in the supply position from non-dollar sources, it is stated, has made these modifications possible, and the need to maintain waste paper salvage at the highest possible level remains as great as ever.

Symposium on Animal Speciation

A symposium on "Ecological and Genetic Factors of Speciation in Animals" was held by the Istituto Italiano di Idrobiologia, Pallanza (Novara), Italy, during July 29–August 2. The meeting was sponsored by the Consiglio Nazionale delle Ricerche (Italian National Research Council), whose general secretary, Dr. A. Morelli, opened the symposium, which was attended by thirty-four biologists. Papers were read by: E. Baldi, Pallanza (isolation mechanisms in populations of plankton freshwater crustaceans); M. Benazzi, Pisa (genetic-systematic studies on Triclades); F. G. Brieger, Piracicaba (heterosis in population-genetics and evolution); H. Burla, Zurich (ecology of *Drosophila* species of Switzerland); U. D'Ancona, Padua (Nemi's Daphniæ during twenty-five years of observations); A. Dreyfus, São Paulo (sex-ratio in hybrids and its interpretation by the study of salivary chromosomes); M. Galgano, Florence (ecological and genetic factors in the sexual cycle of amphibians); J. B. S. Haldane, London (importance of disease in evolution and speciation); J. Heuts, Louvain (ecological and genetic factors in the speciation of the fish *Gasterosteus aculeatus*); F. Mainx, Vienna (chromosomal races of the Agromyzine *Lirryomiza*); B. Rensch, Münster (histological transformations by change in body size); H. Spurway-Haldane, London (comments on Vavilov's law of homologous variation); V. Tonolli, Pallanza (isolation and stability of high-mountain Diaptomid populations); L. Trevisan, Pisa (evolution of the elephants during the Quaternary). Prof. Th. Dobzhansky, of Columbia University, New York, introduced the theme for discussion, and at the end of the meeting summed up the proceedings. The papers will be published in a special volume, edited by the Consiglio Nazionale delle Ricerche.

The Night Sky in February

Full moon occurs on Feb. 13d. 09h. 08m., U.T., and new moon on Feb. 27d. 20h. 55m. The following conjunctions with the moon take place: Feb. 13d. 22h., Saturn 3° S.; Feb. 23d. 23h., Jupiter 5° N.; Feb. 25d. 07h., Mercury 6° N.; Feb. 26d. 15h., Venus 4° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Feb. 10d. 08h., Mercury 4° N. Mercury sets less than half an hour after the sun on Feb. 1 and is in inferior conjunction on Feb. 2. At the middle of the month the planet is stationary and rises an hour before sunrise, but it is not favourably placed for observation during February. Venus is a morning star, rising at 6h. 56m., on Feb. 1 and 14, and at 6h. 40m. towards the end of the month, but is then too close to the sun for observation. Mars is still too close to the sun for favourable observation. Jupiter rises at 6h. 35m., 5h. 55m. and 5h. 08m. on Feb. 1, 14 and 28, respectively, and can be seen, but not favourably, for a short time in the eastern sky. Saturn is in opposition to the sun on Feb. 21 and is visible in the constellation of Leo Major, a little east of Regulus, during the night. Occultations of stars brighter than magnitude 6 are as follow: Feb. 3d. 21h. 13·4m., *e* Pisc. (*D*); Feb. 4d. 20h. 43·4m., 54 Ceti (*D*); Feb. 15d. 22h. 47·1m., η Virg. (*D*); Feb. 15d. 23h. 34·3m., η Virg. (*R*). *D* and *R* refer to disappearance and re-appearance, respectively, and the latitude of Greenwich is assumed.

Announcements

The Committee of Privy Council for Agricultural Research has appointed Prof. F. T. Brooks, who has recently retired from the chair of botany in the University of Cambridge, to be a member of the Agricultural Research Council. This is Prof. Brooks' second term of office as a member, his first being during 1941–46.

The Swiney Prize for 1949 has been awarded, on the recommendation of a joint committee of the Royal Society of Arts and the Royal College of Physicians, to Prof. John Glaister, of the University of Glasgow, for his work "Medical Jurisprudence and Toxicology". This is the second occasion on which Prof. Glaister has received the Swiney Prize, it having been awarded jointly to him and Prof. J. C. Brash in 1939 for their book "Medico-Legal Aspects of the Ruxton Case". The Prize, which is offered alternately for medical and general jurisprudence and consists of a £100 silver cup and money to the same amount, is awarded on every fifth anniversary of Dr. George Swiney's death on January 21, 1844.

Mr. A. L. Bacharach has been appointed to the staff of the Public Relations Director, Glaxo Laboratories, Ltd.; his long scientific and editorial experience will thus be available to assist all sections of the Company's public relations organisation. Dr. W. F. J. Cuthbertson will succeed him as head of the Nutrition Unit, Research Division, of Glaxo Laboratories, Ltd.

The date for the receipt of applications for the Nuffield Foundation Research Fellowship in Extraction Metallurgy has been put forward to March 31, 1949. The Fellowship will be tenable at the Royal School of Mines, London, for a period of up to five years, and the funds available are sufficient to provide a salary of £1,200–£1,500 a year, as well as some £2,500 a year for assistants and apparatus. Applications should be sent to the Secretary, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

Referring to the communication "Occurrence of *Acanthocephalus ranæ* Schrank. in Great Britain" (*Nature*, 162, 1001; 1948), Dr. N. B. Eales, of the University of Reading, writes: "Mr. R. Phillips Dales has recorded the occurrence of *Acanthocephalus ranæ* from the duodenum of frogs from either Cornwall or Surrey. We have also obtained this parasite from frogs caught locally during 1948. It is therefore not improbable that the specimens at Queen Mary College came from the frogs in the neighbourhood of London."

Erratum. In the communication "Relationship Between the Average Carcase Weight of Rams, Ewes and Lambs" (*Nature*, January 15, p. 100), for "$R + E = \Pi L$", read "$R + E = \pi L$".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Disintegration of Boron-10 by Protons

The Atomic Energy Research Establishment, Harwell, has recently produced a number of separated stable isotopes in milligram quantities. The availability of such isotopes has already enabled new nuclear reactions to be discovered, and old ones to be confirmed. In this and a later communication we wish to report on some work of this nature with boron and magnesium.

In the work with boron we have observed the α-particles expected in the reaction[1]

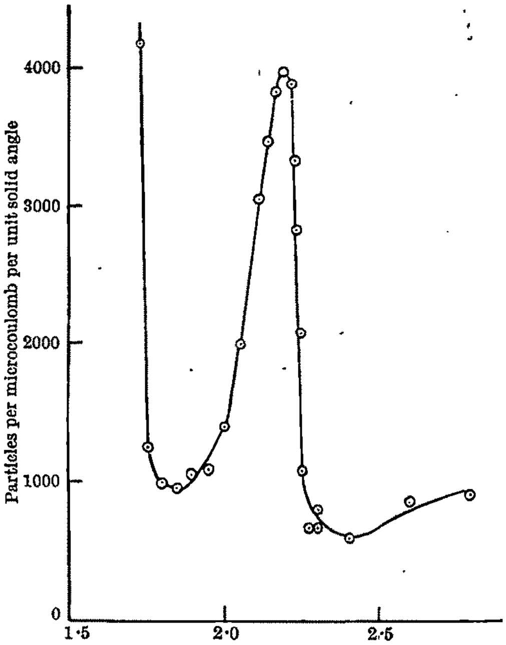
$$B^{10} + H^1 \rightarrow Be^7 + He^4 \tag{1}$$

by using the magnetic analyser and photo-electric multiplier described in a previous communication[2]. Short-range α-particles from the disintegration of boron-11 were eliminated by using a target of separated boron-10. The accompanying graph shows the number of particles counted as a function of current through the analyser coils, for a proton energy of 530 kV.; the α-particle group from reaction (1) is clearly resolved from the scattered protons. The yield of α-particles was found to increase smoothly as the proton energy was varied between 400 and 800 kV.

The energy of the α-particles was measured by putting an absorption cell with a 2-mm. mica window between the analyser and the fluorescent screen, and finding the pressure in the cell at which the particles were cut off. This was compared directly with the cut-off pressure for the α-particles from the reaction[3]

$$Be^9 + H^1 \rightarrow Li^6 + He^4, \tag{2}$$

for which the Q-value was taken to be 2·074 MeV. The difference in extrapolated range of the α-particles from reaction (1) at 630 keV. proton energy, and from reaction (2) at 860 keV., was found to be 0·35 ± 0·01 cm. of air; if the difference in straggling of the two groups is neglected, this gives a mean range of 0·56 ± 0·01 cm. for the α-particles from reaction (1). The corresponding energy release is 1·04 ± 0·06 MeV., using the Cornell range velocity curve[4]. This is to be compared with the value of 1·15 MeV. predicted from the masses[5].



Disintegration of boron-10 by 530-kV. protons; magnetic analysis of particles from the target

As a check on this energy release the magnet current at which the α-particles from reaction (1) were observed was accurately determined. By comparing this with the current necessary for the observation of other known α-particle groups, including that from reaction (2), an energy release of 1·05 ± 0·07 MeV. in reaction (1) was obtained, in good agreement with the result from the range measurement.

It is possible that the beryllium-7 nucleus is formed in an excited state in reaction (1), but we have been unable to find any evidence of α-particles corresponding to transitions to the ground-state in numbers exceeding 10 per cent of the main group at the particular angle of observation (83° with the incident protons).

We wish to thank Sir John Cockcroft and Dr. W. D. Allen and members of his group at the Atomic Energy Research Establishment, Harwell, who supplied the boron-10 target used. One of us (J. M. F.) is indebted to the Australian Council for Scientific and Industrial Research for a studentship.

W. E. Burcham
Joan M. Freeman

Cavendish Laboratory,
Cambridge. Nov. 19.

[1] Roberts, Heydenburg and Locher, *Phys. Rev.*, **53**, 1016 (1938). Rumbaugh, Roberts and Hafstad, *Phys. Rev.*, **54**, 654 (1938).

[2] Freeman and Baxter, *Nature*, **162**, 696 (1948).

[3] Rosario, *Phys. Rev.*, **74**, 304 (1948).

[4] Holloway and Livingston, *Phys. Rev.*, **54**, 18 (1938).

[5] Bethe, "Elementary Nuclear Theory", 124 (Wiley, New York).

Specific Ionization of Fast β-Particles in a Mixture of Air and Ethyl Alcohol – Water Vapour

Curran and Reid have given an account[1] of their investigations on the primary ionization of β-particles in mixtures of argon and ethyl alcohol vapour. I have carried out some experiments on the specific ionization of fast β-particles in a mixture of air and ethyl alcohol – water vapour[2].

A detailed study was made of the influence on the ionization in air of the mixture of ethyl alcohol and water generally used as a source of vapour in the Wilson cloud chamber. To this end both the probable and the primary ionization in air were determined at three pressures, namely, at 1, ½ and ¼ atmosphere. Assuming the specific ionization in pure air in this region to increase linearly with the pressure, it is possible to deduce from the observed values the specific ionization in the vapour-mixture.

The experiments were made for β-particles of various energies, namely, with a ρH of 1,200, 1,600, 2,000 and 2,400 gauss/cm. The mean specific ionization in ethyl alcohol – water vapour (liquid 60/40 by volume) at 0° C. and 1 cm. mercury pressure, at the energies stated, was 3·86, 3·24, 2·71, 2·45 ion pairs/cm. for the probable ionization and 2·22, 1·68, 1·35, 1·18 ion pairs/cm. for the primary ionization respectively.

It follows from these figures that the mean specific primary ionization for a β-particle of energy 0·4 MeV.

in an ethyl alcohol – water vapour mixture at 0° C. and 76 cm. mercury pressure amounts to about 90 ion pairs/cm., a number which is somewhat higher than the value of 79 ion pairs/cm. for alcohol vapour found by Curran and Reid and determined by the method of placing two counters in a spectrograph.

W. J. BEEKMAN

Physical Laboratory,
University of Utrecht.
Nov. 14.

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[1] Curran, S. C., and Reid, J. M., *Nature*, **160**, 866 (1947).

[2] Beekman, W. J., *Physica*, **12**, 534 (1946).

Directional Correlation between Successive Internal-Conversion Electrons from Tantalum-181*

HAFNIUM-181 decays with a 48 day half-life to a 20-microsecond metastable state[1] of tantalum-181. From this, two γ-rays are emitted in cascade, with internal conversion coefficients $N_e/(N_e + N_\gamma)$ approximately 0·6 and 0·06 [2]. We wish to report some measurements on the directional-correlation between these successive conversion electrons.

2 mgm. of finely divided hafnia, irradiated with slow neutrons in the Harwell pile to give hafnium-181, was used as a source. Self-absorption in the source of the softer conversion electrons was appreciable. Four Geiger–Müller counters with 2·3-mgm./cm.^{2} windows were placed around the source, each 6 cm. away from it. They were arranged as two pairs to measure the instantaneous coincidence-rates C for two angles at the same time. Angles of 90° and 180° have been used, with an angular resolution of ± 8°. Each counter fed very short pulses (0·3 microsecond) into its coincidence unit, so that delayed coincidences were practically eliminated and the correction for random coincidences was small. The anisotropy was found to be

$$\frac{C\,(180^\circ) - C\,(90^\circ)}{C\,(90^\circ)} = -\,0{\cdot}32 \pm 0{\cdot}08.$$

Check experiments on secondary electrons from unconverted γ-rays showed that effects from these were small.

Extensions of such experiments are being considered, as well as the theoretical implications regarding the multipolarity of the transitions involved and spins of the corresponding nuclear states.

A. H. WARD
D. WALKER

Physics Department,
University,
Edgbaston, Birmingham 15.
Nov. 11.

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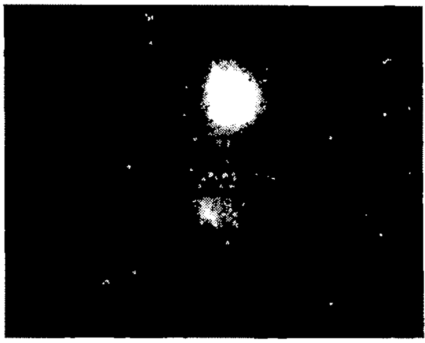
[1] De Benedetti, S., and McGowan, F. K., *Phys. Rev.*, **70**, 569 (1946).

[2] Bunyan, D. E., Lundby, A., Ward, A. H., and Walker, D., *Proc. Phys. Soc.*, **61**, 300 (1948).

A New Phenomenon in the High-Pressure Mercury Vapour Discharge

THE mechanism of the positive column of the high-pressure mercury vapour discharge appears to be now well understood[1]. It has been a basic assumption in all the theoretical work—and this has been borne out by general experience of the behaviour of the discharge—that the positive column is substantially uniform in all properties along the whole of the distance between the electrodes, at least to within less than a millimetre from the discharge terminations. It is true that there are some exceptions: the column often tends to contract near the electrodes, and in long vertical burning tubes this effect is more marked at the lower end. This contraction is not difficult to understand, and its accentuation at the lower electrode is due to the higher density there compared with that at the upper end of the tube. It is true also that very close to the cathode small intense bright spots may often be seen[2], but it has always seemed likely that this was associated with a purely surface effect on the electrode; and there has been no evidence to suggest that in the high-pressure condition any appreciable degree of axial non-uniformity could be produced.

For some time we have been making observations on discharges in mercury vapour at pressures of the order of 5 atmospheres, and with arc-lengths of the order of 10–20 mm., which are somewhat surprising in view of this long-accepted background.



Bright region in the neighbourhood of the cathode of a high-pressure mercury-vapour discharge showing intense barium spectrum

If a small amount of a relatively easily ionized vapour, such as sodium or barium, is evaporated into the positive column of such a discharge, at high loadings (of the order of 1 kW. per cm. of arc), a large intense region may be produced extending from the cathode over a substantial part of the distance between the electrodes. The accompanying photograph—which was taken through a Wratten 25 filter with a *P*1200 plate—shows the bright region produced in the neighbourhood of the cathode of a D.C. discharge, by the addition of a small quantity of barium vapour to the high-pressure mercury vapour. This bright area has fairly clearly defined edges and radiates an intense Ba spectrum with—less strongly—that of Ba$^+$. Its luminance is some 40,000 Sb., which is about twice that of the remainder of the arc. The phenomenon in its present form seems to be mainly associated with the cathode function, since it appears at this electrode whatever the position of burning of the arc.

Another property which the photograph incidentally shows is that the intense region can be preferentially deflected in a magnetic field.

There are indications that similar phenomena occur in the rare gases at high pressures.

The fact that quite small quantities of an easily ionizable substance are able profoundly to affect the properties of the positive column is not very unexpected; but that a cathode phenomenon of this magnitude can be so produced is of considerable theoretical interest and warrants further study. It is hoped shortly to publish this work in detail.

V. J. FRANCIS
G. G. ISAACS

Research Laboratories,
The General Electric Co., Ltd.,
Wembley.
July 27.

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[1] See, for example, Elenbaas, W., *Phil. Res., Rep.*, 2, 20 (1947). Francis, V. J., *Phil. Mag.*, 37, 433, 653 (1946), and references given therein.

[2] Nelson, E. H., *G.E.C. J.*, 14, 73 (1946). Bourne, H. K., *B.T.H. Act.*, 19, 181 (1947).

Radial Patterson Distribution Functions

IT has been indicated in a previous paper[1] how a comparison between the structure factors ($F(h,k,l)$) resulting from a given molecular configuration, and those actually observed by experiment, can be effected by comparing the Patterson maps resulting from the observations and from the proposed molecule. This suffers the disadvantage of requiring a knowledge, not only of the intra-molecular configurations, but also of the positional relationships between the molecules themselves in the unit cell. Another approach is suggested by a result obtained recently[2]. Since the Patterson synthesis, in a certain neighbourhood of the origin, depends mainly upon the intramolecular configuration, a possible basis of comparison between a postulated molecular structure and a set of observations would lie in an investigation of the distribution functions resulting from each in *Patterson* space.

It is simple to obtain the radial Patterson function of a given molecule by the processes of elementary geometry. We now investigate very briefly the technique for deriving the same function from the observed $|(F(h,k,l)|^2$ values.

For a radially symmetric function $T(R)$, the corresponding radially symmetric function in the reciprocal space is

$$g(r) = 4\pi w \int_0^\infty R^2 T(R) \left[(\sin 2\pi.rR)/(2\pi.rR)\right] dR,$$

where w is the total weight of $g(r)$ and T is scaled to value unity at the origin. For a cylindrically symmetric function $T(RZ)$, the corresponding function in the reciprocal space is[2]

$$g(rz) = 2\pi w \int_{-\infty}^{\infty} \int_0^\infty RT(RZ)\, J_0(2\pi rR) \exp(-2\pi izZ)\,.\, dRdZ.$$

Hence the three-dimensional radial Patterson function for a unit cell of volume V may be written

$$g_3(r) \doteqdot (1/V) \sum_3 |F(h,k,l)|^2 \sin(2\pi rR_{h,k,l})/(2\pi rR),$$

where $1/R_{h,k,l}$ is the spacing of the plane (h,k,l). The two-dimensional radial Patterson function for a unit cell of volume V may correspondingly be written

$$g_2(r) = (1/A) \sum_2 |F(h,k,o)|^2\, J_0(2\pi rR_{h,k,o}).$$

Applications of the above methods to crystalline powders have been pointed out elsewhere[3], but we wish to remark here their special suitability to work in proteins. In this field a number of theories have been advanced for the structure of single molecules, and any check has been rendered difficult since it requires, not only a knowledge of the single molecule, but also of the relationship which this bears to its fellows in the unit cell. The present technique may permit a first comparison to be made without any consideration of intermolecular structure and with only limited computations. This is important since it will enable certain structures to be ruled out immediately. We wish to emphasize, however, that it can never establish the correctness of a given structure, but only its right to inclusion in the general class of possibilities.

ANDREW D. BOOTH

Birkbeck College,
London.

DOROTHY WRINCH

Smith College,
Amherst, Mass.
July 27.

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[1] Booth, A. D., and Wrinch, D., *J. Chem. Phys.*, 15, 416 (1947).

[2] Wrinch, D., "Fourier Transforms and Structure Factors", A.S.X.R.E.D. Monograph No. 2, 10 (1946).

[3] Booth, A. D., *Trans. Farad. Soc.*, 44, 37 (1948).

A Mechanical Calculating Machine for X-Ray Structure Factors

A LARGE mechanical machine for calculation of X-ray crystallographic structure factors has now been completed in our laboratories and is running satisfactorily. The machine is of a tide-predictor type, and it deals with up to 24 harmonic components at a time.

The expression calculated is

$$F\,(hkl) = \sum_i f_i \cos 2\pi\,(h\,x_i + k\,y_i + l\,z_i).$$

During the calculation, for example, h and k are kept constant and the machine calculates F for all required l values at one setting. If there are N atoms per unit cell, N harmonic units are switched on; each unit has a phase dial on which is first set the value $h\,x_i + k\,y_i$. The values z_i are set on a multiplier bar, which at each stroke adds these through a clutch to the values on the dials with an accuracy better than 1 : 1,000. After l strokes, the dials thus read $h\,x_i + k\,y_i + l\,z_i$. Their angles are transferred to cosine arms, each of length f_i, the results of which are added together by means of a pulley belt differential with an accuracy better than 0·2 per cent of $F(000)$. An output pulley indicates on two geared-down dials the resulting values of F. The calculation assumes that the variation of f_i with index is the same for all the atoms; heavy atoms must thus be treated separately.

The machine has provision for calculation of Booth corrections[1] ε from the derivatives of R. For this purpose the errors $F_0 - F_c$ are copied from a drum and thus fed into the machine. The machine is run again, but with $\pi/2$ added to the angles of the phase dials of the harmonic units, so that their arms produce sines instead of cosines. There is an arrangement which multiplies these by $W\,(F_0 - F_c)$. The weights W are chosen according to the formula for R used[2], and according to whether x, y or z co-ordinates are to be corrected. The products are summed up on the ε dials for all l. After completing the run, the ε dials read the corrections by which the co-ordinates should be altered to decrease R. The cycle of calculations is represented in Fig. 1.

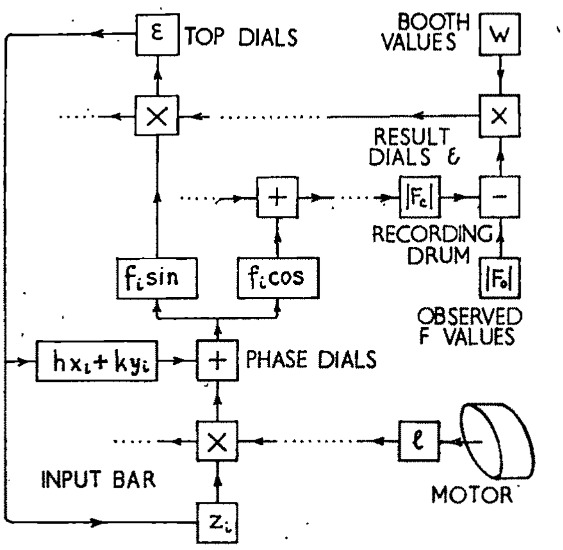

Fig. 1. Calculation cycle of the machine, using Booth's method of steepest descents

The machine is electrically driven, and the drive is automatically controlled, stopping after completion of a predetermined sequence of operations. Taking into account the setting times, it is about thirty times faster than manual methods. The output is of sufficient power to drive a registering pen mechanism. If desired, absolute values can be plotted automatically, each coded by means of a small kink in the curve; positive values have the kink upwards, negative downwards. A plot of *F* values is shown in Fig. 2.

Although this machine was designed for calculation of structure factors, it can be used for Fourier synthesis of the electron density. As the lengths of the cosine arms are not readily adjustable, it is best to set all their lengths equal. The structure factors can then be represented as a sum of two vectors of unit length, differing in phase. The machine is run separately for each set of unit vectors and the results added. A unidimensional continuous electron density tracing is then obtained.

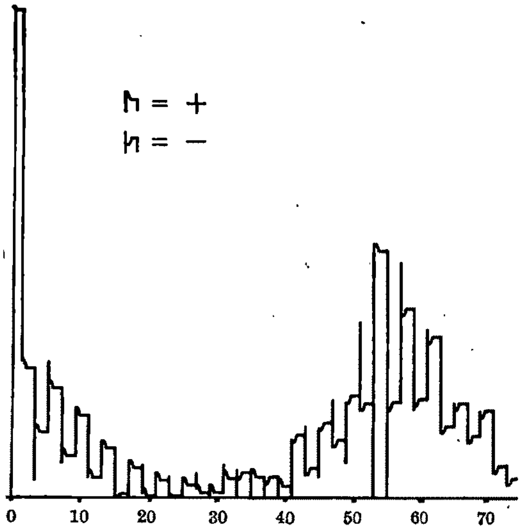

Fig. 2. Automatic recording of *F*(00*l*) values of strontium laurate for *l* up to 74 (odd values of *l* absent). Scale: *F*(000) = 1040 electrons

'Ecofix' girders and 'Meccano' were used for parts where high accuracy was not required; this reduced the cost of the machine considerably and enabled us to build it in less than six months.

I wish to thank Mr. E. T. Sanders for machining the more accurate components.

V. VAND

Research Department,
Lever Brothers and Unilever, Ltd.,
Port Sunlight, Cheshire.
July 27.

[1] Booth, A. D., *Nature*, **160**, 196 (1947).

[2] Vand, V., *Nature*, **161**, 600 (1948).

Quadrupole Rotation-Vibration Spectrum of the Hydrogen Molecule

It is usually considered that molecular hydrogen does not have an infra-red rotation-vibration spectrum. However, such a spectrum may be expected as a forbidden transition made possible by the change of quadrupole moment during the vibration[1]. The predicted intensity of this spectrum is so low that a path of the order of 10 km. at atmospheric pressure is required to obtain it in absorption[1,2].

Using a pipe of 22 m. length and letting the light pass through it up to 250 times[3] at a pressure of 10 atmospheres, it was possible to obtain equivalent path-lengths up to 55 km. atmospheres. Under these conditions a number of lines of the 2–0 and 3–0 bands of the hydrogen quadrupole spectrum were indeed observed. The accompanying table compares the observed wave numbers with those predicted from the ultra-violet hydrogen spectrum[1]. The bands have only *S*, *Q* and *O* branches. Because of the small moment of inertia of the hydrogen molecule, only the first few lines of the *S* and *Q* branches are sufficiently intense for observation. No lines of the *O* branches were found.

Wave-numbers of quadrupole lines of H_2

Band	Line	ν (predicted)	ν (observed)
2–0	*S*(0)	8,403	8,406·36
2–0	*S*(1)	8,601	8,604·26
2–0	*S*(2)	8,782	8,785·54
2–0	*Q*(1)	8,072	8,075·42
3–0	*S*(0)	12,080	12,084·66
3–0	*S*(1)	12,261	12,265·55
3–0	*S*(2)	12,420	12,424·44
3–0	*Q*(1)	11,760	11,764·96

The slight systematic difference of observed and predicted wave-numbers is due to the much lower wave-number accuracy in the vacuum ultra-violet and the lack of standards in this region. It is hoped to obtain improved rotational and vibrational constants of the hydrogen molecule in the ground-state from the wave-numbers of the quadrupole lines.

It appears that the spectrum here observed is the first example of quadrupole radiation in molecular spectra.

G. HERZBERG

Yerkes Observatory,
Williams Bay, Wis.
Aug. 24.

[1] See Herzberg, G., *Astrophys. J.*, **87**, 428 (1938).

[2] James, H. M., and Coolidge, A. S., *Astrophys. J.*, **87**, 438 (1938).

[3] Bernstein, H. J., and Herzberg, G., *J. Chem. Phys.*, **16**, 30 (1948).

Radiation Pressure of Centimetre Waves

THE pressure exerted on a perfectly specular surface by a normally incident beam of electromagnetic waves travelling in free space can be calculated with the known formula

$$p = 2S/c,$$

where S is the Poynting vector and c the speed of light.

Many experiments have been performed in order to measure the pressure exerted by light waves, among which those by Amerio[1] seem to be particularly elegant. Lebedew[2] has found for the radiation emanating from the sun a pressure of the order of 10^{-5} dyne/cm.^{2}. The radiation pressure of electromagnetic waves produced by ordinary radio transmitters is smaller still and cannot be detected by direct means, since the wave-lengths involved are too large and the power does not reach adequate levels. The invention of new tubes (magnetrons) capable of generating high-power centimetre waves has made it possible to measure the radiation pressure of such radiation.

Using a 725 A.-type magnetron generating bursts of radio-frequency energy ($\lambda = 3$ cm., duration of each burst 1 μsec. with a recurrence of 1,000 cycles per second) of a mean value of 50 watts, the pressure exerted by the energy impinging on a surface of 2 cm.^{2} (cross-section of rectangular wave-guide) is of the order of 10^{-2} dyne/cm.^{2}.

In order to detect such a pressure we have carried out the following experiments: before the mouth of a rectangular wave-guide excited by the above-mentioned magnetron, we placed the aluminium blade (6 cm.^{2} cross-section) of a symmetrical torsion balance, having an arm 2 cm. long, protected by a glass cover. Observation was carried out in a rarefied atmosphere of 10 mm. mercury pressure approximately in order to minimize radiometer effects. The distance between the blade and the mouth of the wave-guide was never less than 4 cm. in order to avoid ionization under the action of the intense radio-frequency field.

Thus the blade was picking up only a fraction of the radiated energy. Different observations have been made at various points of the field. When intercepting the maximum radiation (approximately one fifth of the total available power), the balance indicates a torque of 10^{-2} dyne/cm. Diffraction phenomena explain this result, which is smaller than the theoretical torque corresponding to a force obtained by calculating the product of the pressure of the intercepted radiation by the effective cross-section of the blade.

In a theoretical paper[3], in which the propagation of the electromagnetic field in a wave-guide has been studied starting from relativistic considerations, we have demonstrated that within a (rectangular) wave-guide the pressure must be calculated with the formula:

$$p_g = 2Sv_g/c^2,$$

where v_g is the group velocity, which is known to be less than c. We deduce from it a radiation pressure within the wave-guide less than the free space radiation pressure.

Measurements of p_g are under way, and since v_g is a calculable quantity, we hope to be able to obtain as final result the value of S and consequently the generated power.

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Firenze.

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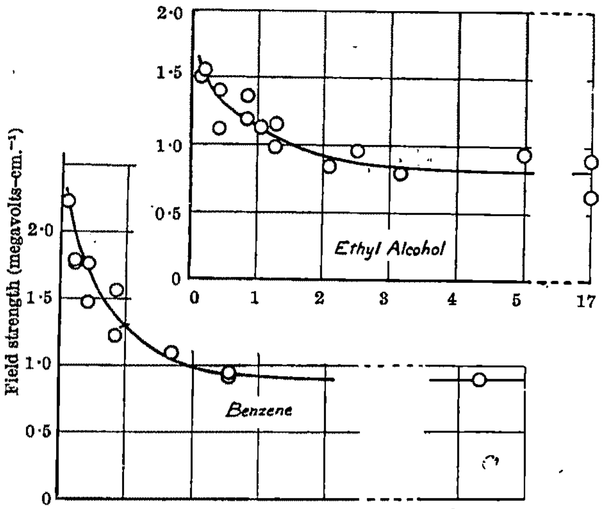
Dielectric Strength of Liquids for Short Pulses of Voltage

EXPERIMENTS in progress here show a systematic increase in the dielectric strength of pure organic liquids as the duration of the pulse of voltage is decreased. In other words, between the instant of applying a field and the instant of breakdown there is a time-delay which becomes less as the field-strength is raised above the normal breakdown value. A suggestion of this delay can be seen in the early oscillograms of Rogowski, Flegler and Tamm[1].

We have used pure organic liquids of relatively simple molecular structure, both polar and non-polar. The accompanying graph shows the experimental relation between breakdown field-strength and pulse duration for benzene and alcohol. The experiments were performed at room temperature.



Dependence of dielectric strength upon pulse duration for benzene and alcohol

To avoid the considerable errors due to minute amounts of impurity, an apparatus has been constructed in which the liquid can be distilled *in vacuo* into the testing vessel. Single rectangular pulses of voltage are applied from a thermionic pulse generator to a pair of polished metal spheres immersed in the liquid and capable of being rotated from outside the vessel to present a fresh surface to the gap after a spark has occurred. We find that this apparatus reduces the 'spread' in the measurements, though a small proportion of the pulses still produce breakdown at field-strengths below the minimum value for consistent rupture, which we regard as the 'breakdown field-strength'. However, accidental lack of ionization does not seem to play a major part in delaying breakdown, as in gases.

A high-speed single-stroke cathode ray oscillograph is used to observe and measure the pulses. We agree with Rogowski and his collaborators that the breakdown, when once started, becomes complete in about 10^{-9} sec.

A recent theory[2] of breakdown in amorphous dielectrics indicates that, above a certain critical field-strength, instability of the energy of the electrons in the conduction band occurs. It does not, however, go into the question of the time required to reach the state of instability from the moment of applying the field, neither does it deal with the events following the establishment of the unstable state. It is hoped that further experiments will show whether the time-delay we have found is associated with one or both of these possible causes.

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Frictional Electrification

Recent experiments on the so-called frictional electrification produced when dielectrics slide over conductors appear to throw light on the mechanism of its production.

Small cubes of ebonite or a measured volume of sand were allowed to slide down an earth-connected inclined metal plane and fall into a tin connected to an electrometer triode valve. The bodies were carefully discharged before starting, and the reading of the valve instruments gave a measure of the charge acquired in the slide. Above and parallel to the runway was another plate insulated from it, and by putting a potential between the two plates the specimens could slide in an electric field perpendicular to the sliding surface—there was an air gap of a centimetre or so between the top of the specimen and the upper plate.

It was found that this electric field had a considerable effect on the frictional charges produced, and that there was the simple relation

$$Q = -AX - Q_0$$

for any particular specimen, where Q was the frictional charge for an electric force of X volts per cm., $-Q_0$ was the frictional charge when sliding in zero field and A was a constant (X was taken as positive when the upper plate was at a positive potential to the lower).

Thus with ebonite or sand in zero field, a negative charge was produced; making the top plate positive increased the magnitude of this charge, while making it negative decreased it, and if sufficiently negative reversed its sign. In each case for a negative field, given by the value Q_0/A for the substance, no charge was produced by the slide. This effect of an electric field gives a clue to the mechanism of frictional electricity.

The only way in which the dielectrics can acquire the charge is by the passage of electrons to or from the plate down which they slide. There is, thus, although the dielectrics are insulators, a leakage of charge over the contact surface, which continues until the external field is neutralized. If this were all, the curve connecting Q and X would be a straight line through the origin. The fact that it is a straight line but not through the origin proves that another field must also be present, due to a type of contact difference of potential between the dielectric and the plate. When there is no field, the passage of charge to neutralize this contact potential gives rise to the charges known as frictional electricity.

The effect of an external electric field, besides its theoretical interest, may have a practical use; because by the application of the appropriate field Q_0/A (usually a moderate one of a few hundreds of volts per cm.) it is possible to prevent sliding particles getting any charge at all and thus get rid of certain dangers due to frictional electricity.

It would, however, be over-optimistic to expect a complete cure, because the phenomenon being a surface one, the magnitude of Q_0 and A, and therefore of Q_0/A, depends on the texture of the surfaces, their cleanliness, their dryness, their temperatures and so on; all of which may be varying with time. But even so, a considerable reduction in average frictional charges should be possible.

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Action of Acetylcholine on Rabbit's Auricles in Relation to Acetylcholine Synthesis

When the heart is removed from a freshly killed rabbit, the auricles can be dissected and put in a bath of Tyrode solution at 28° C. in which they continue to beat. The addition of acetylcholine to the bath slows the rate and diminishes the amplitude of the contractions.

After 24–36 hr., the auricles stop beating. The addition of acetylcholine to the bath at this point can restart the contractions, and further additions may increase the rate and amplitude. If the acetylcholine is removed without delay, the beat stops again; once, however, spontaneous activity is fully developed, removal of the starting dose does not arrest the beat, but it continues for an hour or more. Thus when the auricle stops beating, it appears to require acetylcholine in order to resume activity, which is then maintained. We have found a close correspondence between the functional state of the auricles and enzymic activity present in them. If an acetone-dried powder is prepared from auricles, it synthesizes acetylcholine in the conditions described for brain tissue by Feldberg and Mann[1]. The average figure for freshly excised auricles was 40 μgm. acetylcholine per gm. acetone powder per 75 min. We found that auricles which had stopped beating after 24 hr. in the bath lost most of their synthesizing power, the average figure being 15 μgm. per gm. Auricles which resumed activity after the addition of acetylcholine to the bath regained their synthesizing power, the average figure being 37 μgm. per gm.

The indication given by these figures of a connexion between activity in the living tissue and power to synthesize acetylcholine was borne out by observations of the effect of acetylcholine on its synthesis. Addition of acetylcholine to a powder (5–80 μgm. per gm. powder) from fresh auricles reduced the acetylcholine synthesis to 30 per cent of its control value. On the other hand, addition of acetylcholine to a powder from stopped auricles increased the acetylcholine synthesis to more than twice the control value.

Thus the action of acetylcholine is inhibitor when applied to auricular tissue in which the rate of synthesis is high; it inhibits the beat and it depresses the synthesizing power. On the other hand, the action of acetylcholine is motor when applied to auricular tissue in which the rate of synthesis is low; it can start the beat and it augments the synthesizing power.

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Failure of Antihistamine Drugs to Inhibit Hyaluronidase *in vitro*

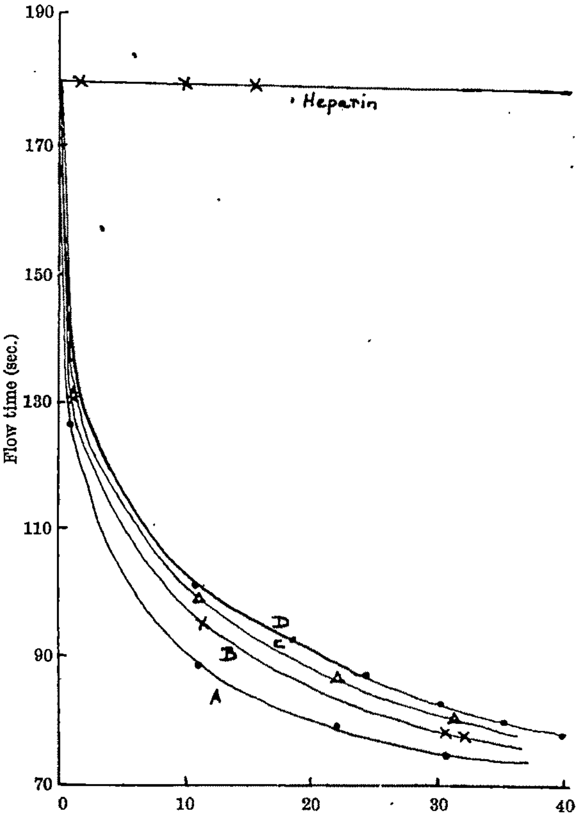
Mayer and Kull[1] have demonstrated that 'Pyribenzamine' and 'Antistin' counteract the spreading effect of hyaluronidase, and have claimed, therefore, that these antihistamine drugs exhibit a strong anti-hyaluronidase action. In view of the failure by Swyer[2], using an *in vitro* technique, to confirm a similar claim by Guerra[3,4] with respect to a supposed anti-hyaluronidase property of salicylates, it was decided to investigate the effect *in vitro* of various concentrations of some antihistamine drugs upon the hyaluronidase system.

Hyaluronidase preparations were obtained from rabbit and rat testis by a modification of the method of Kass and Seastone[5]. Enzymatic activity was measured in a No. 1 suspended-level viscometer. All estimations were carried out in a thermostat at 34° C.; this temperature was chosen because the work described here is part of a study of related problems in skin.

Viscosity reduction curves were obtained by a modification of the method of McClean and Hale[6], the flow-time of a mixture of 18 ml. buffer-substrate (4 vol. 0·12 per cent w/v aqueous hyaluronic acid and 1 vol. McIlvaine's citric acid–posphate buffer *p*H 7·0 containing 3·5 gm. sodium chloride/litre), 1 ml. buffer (or anti-histamine drug) and 1 ml. of testis extract, being measured at 2, 10, 20 and 30 min. after mixing. Prior to mixing, the solutions were filtered through a sintered glass funnel of porosity *G*4, and brought to 34° C.

Solutions containing 0·003, 0·033 and 0·33 per cent of (1) 'Antistin', (2) 'Benadryl', (3) 'Pyranisamine' and (4) 'Pyribenzamine', buffered so that the *p*H of each fell within the range 6·8–7·2, were tested for possible anti-hyaluronidase activity. In no case was there any evidence of significant inhibition of the enzyme. The latter was completely inactivated in the absence of chloride by the addition of 3·8 units of heparin per ml. reaction mixture. The effects of varying concentrations of 'Benadryl' upon the enzyme system are shown in the accompanying graph.

The above findings, therefore, show that, under our conditions, these drugs have no direct anti-hyaluronidase activity. Mayer and Kull, however, were careful to point out that their *in vivo* effects may be the result of a non-specific process. The work of Hechter[7] on the mechanism of the spreading effect of hyaluronidase in skin suggests, indeed, that this may be the case. Swyer[8] has shown that histamine enhances the spreading effect of hyaluronidase, and Mayer and Kull's findings might, therefore, be due to the action of these drugs on traces of histamine released during the intradermal injection of the spreading factor.



A, enzyme alone; *B*, enzyme in presence of 0·33 per cent 'Benadryl'; *C*, in presence of 0·003 per cent 'Benadryl'; *D*, in presence of 0·033 per cent 'Benadryl'

Our thanks are due to Messrs. Glaxo Laboratories, Ltd., for a gift of hyaluronic acid, to Messrs. Parke, Davis and Co., Ltd., Messrs. May and Baker, Ltd., and Ciba Laboratories, Ltd., for gifts of 'Benadryl', 'Pyranisamine' and 'Pyribenzamine', and 'Antistin', respectively. We would also like to thank Prof. R. H. S. Thompson for his help and encouragement.

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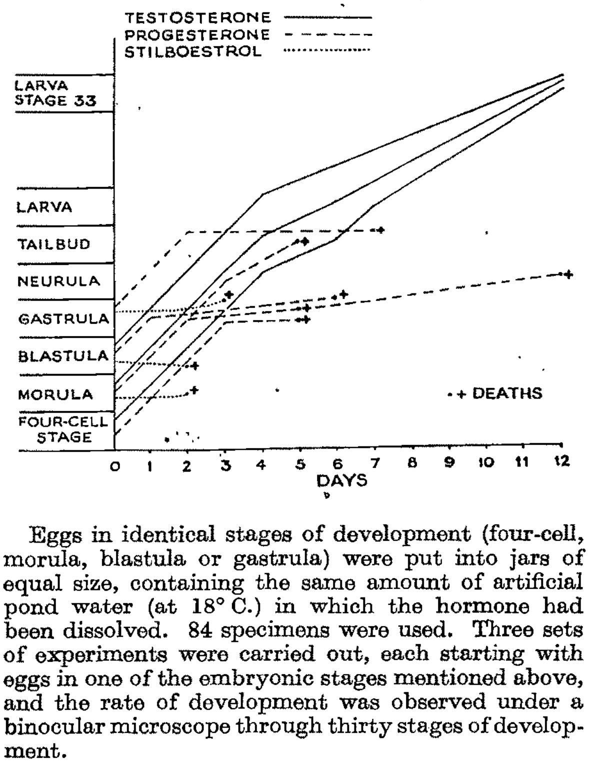
Differences in the Action of Steroids on Amphibian Embryos

In addition to their actions on the sexual organs, the steroids have some characteristic effects on cellular division. Von Möllendorff[1] showed that the frequency of mitosis in tissue cultures of fibrocytes is influenced by alcoholic solutions of 1 : 10,000 to 1 : 5,000,000 testosterone. G. Töndury[2] demonstrated that abnormal mitotic divisions may be produced in amphibian ova by alcoholic solutions of 1 : 100,000 to 1 : 1,000,000 testosterone, œstriol, œstradiol and stilbœstrol.

A study of amphibian embryos has revealed that steroids may retard the rate of development to a varying extent. The following experiments deal with the actions of equal concentrations (1 : 100,000) of testosterone, progesterone and stilbœstrol on the developing amphibian embryo (*Triton tæniatus*).



Eggs in identical stages of development (four-cell, morula, blastula or gastrula) were put into jars of equal size, containing the same amount of artificial pond water (at 18° C.) in which the hormone had been dissolved. 84 specimens were used. Three sets of experiments were carried out, each starting with eggs in one of the embryonic stages mentioned above, and the rate of development was observed under a binocular microscope through thirty stages of development.

Testosterone treatment. Embryos in the four-cell stage develop into a tail-bud stage on the fifth day. The morula stage becomes a blastula in 24 hr. and a gastrula in another 24 hr. Normal young larvæ (stage 33) develop in a fortnight. Development from the blastula stage is normal.

Progesterone treatment. Embryos in the four-cell stage develop into gastrulæ on the fifth day but do not develop further; they die on the seventh to the ninth day, during the process of gastrulation (stage 10–12).

The rate of development of the morula is retarded; it develops into a blastula only after two days. Gastrulation occurs on the third day, but most of the gastrulæ die during the process of gastrulation. The few that develop into neurulæ die on the twelfth to thirteenth day.

A blastula develops into a gastrula in 24 hr., but usually dies without further development after four to five days. A few pass through the neurula stage and die later as tail-bud stages. Gastrulæ also pass through the neurula stage and die as tail-bud stages after seven days.

Stilbœstrol treatment. No further development occurs in embryos which began the experiment in the morula, blastula or gastrula stages, and they die after two to three days.

These experiments show that while testosterone does not affect the development of common newt embryos, stilbœstrol prevents all development. Treatment with progesterone prevents complete development, the embryo dying during gastrulation or in the limb-bud stages.

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Acetate as a Possible Precursor of Ruminant Milk Fat, Particularly the Short-Chain Fatty Acids

The origin of the short-chain fatty acids (C_4—C_{14}) of milk fat has been the subject of much speculation; some believe they originate by degradation of long-chain acids[1,2], others that they are synthesized from carbohydrate[3]. Their occurrence in appreciable quantities only in the milk fat of herbivores, more particularly ruminants[4], may be significant in the light of the fact that considerable quantities of acetate are produced in the rumen and absorbed into the blood[5]. These considerations, together with the demonstration that the body can build fatty-acid chains from acetate[6], suggested in 1945 that acetic acid might be the precursor of a portion of the milk fat, especially the short-chain acids[7].

In 1946 a fruitless attempt[8] was made to verify this theory by intravenous infusion of acetate into lactating goats during inanition, when the short-chain acids of the milk fat are much diminished. These negative results, and others in the cow[9], were probably due to avid utilization of the intravenously administered acetate by the fasting tissues, for ex-

	0·017 *M* glucose			0·02 *M* sodium acetate		
	Q_{O_2}	Q_{acid}	R.Q.	Q_{O_2}	Q_{acid}*	R.Q.
6 Rats.	− 8·7 ± 1·0	+ 2·0 ± 0·6	1·66 ± 0·07	− 4·8 ± 0·3	+ 0·6 ± 0·2	0·75 ± 0·06
6 Goats	− 4·5 ± 0·3	+ 1·5 ± 0·2	0·85 ± 0·04	− 6·2 ± 0·5	− 4·2 ± 0·7	1·20† ± 0·08

37° C.; 95 per cent oxygen + 5 per cent carbon dioxide; Ringer-bicarbonate; *p*H 7·4.
* In the case of acetate a negative value for Q_{acid} is a measure of substrate utilization.
† Significantly greater than unity ($P = 0·03$).

ample, the heart[10], so that adequate blood-levels were not maintained. *In vitro* experiments with mammary gland slices have now provided what we believe to be the first evidence in favour of the new theory of the origin of milk fat (see accompanying table).

Lactating mammary gland slices from all non-ruminants studied—rat[11], mouse, rabbit and guinea pig—have given a high respiratory quotient (measured as before[11]) in the presence of glucose, indicating the probable formation of fat from carbohydrate; on the other hand, the respiratory quotient for slices from the goat (and cow) is well below unity. With acetate as substrate, however, the situation is reversed, goat (and cow) gland now giving a respiratory quotient greater than unity, whereas the rat (and mouse) mammary gland do not appear to utilize acetate. The mammary tissue of the ruminant thus appears to be adapted for metabolizing acetate; and can not only oxidize it, but also, as indicated by the high respiratory quotient *in vitro*, can probably utilize it for fat synthesis, in this respect differing from other mammals, exemplified by the rat, which appear to require carbohydrate as substrate for fat formation. These results are consistent with the theory that in ruminants part of the milk fat is synthesized from acetate (this would explain the high udder respiratory quotient *in vivo*[3,11]); and if this is so, it seems very likely that the short-chain acids in particular arise in this way.

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Criteria of Relationship between Plant Virus Strains

IT is now generally recognized that cross-protective power in the host plant, and serological relationship, are two of the most satisfactory criteria for establishing relationship between plant viruses.

In spite of an early observation by Smith[1], it is usually considered that if two viruses are related strains, then one strain will protect a plant completely from infection by a second strain, provided that the plant is fully infected with the first strain before inoculation with the second.

In experiments in *Datura tatula* and tobacco with six mottle type and four ring-spot type strains of potato virus *X*, it was found that four of the mottle strains protected completely against all the ring-spot strains. However, with two strains of the mottle type (*B* from Duke of York potato[2] and *TBRX* from tomato[3]), necrotic local lesions and systemic necrosis developed following inoculation with any of the ring-spot strains used. However, symptoms were not as severe as in the healthy controls inoculated with the ring-spot strains.

The same set of ten strains was also examined by the serological cross-absorption technique. Six of the strains were indistinguishable by the method used. Two strains had been isolated from the same potato plant, one a symptomless and one a ring-spot type isolated from Salaman's X^h culture[4]. These two strains were serologically indistinguishable, but possessed an antigenic fraction not possessed by any of the other eight strains. Thus, in this case, serological relationship was correlated with source of origin rather than symptom type.

TBRX and *B*, the two strains that did not give complete protection in the host, differed considerably in the serological tests from any of the other strains. They each had a strain-specific antigenic fraction and also shared a fraction not possessed by any of the other eight strains tested.

Thus, within the group of ten strains tested, there was a correlation between serological relationship and the degree of protection afforded in the host plant.

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Infectious Chlorosis of Bananas in Colombia

A DISEASE probably identical or closely allied to the 'infectious chlorosis' or 'heart rot' of bananas, of a virus nature, has recently been found in Cauca Valley, on the Pacific side of Colombia, South America, and is now being studied by the staff of the Agricultural Experimental Station of Palmira.

This is a new record of the disease, previously known, in America, in the islands of Guadeloupe and Haiti[1]. Australian and African records have been reported by Wardlaw[2].

This is also the second time that a virus disease of cultivated plants has been found in Hispaniola Island (Haiti and Dominican Republics) and Cauca Valley, Colombia. I have already published previous records of a disease of the cacao tree of the same geographical distribution[3].

The features of this banana disease coincide with the symptoms described by Magee, Morwood and Wardlaw, with the exception of linear spots (from midrib to margin), which are frequently brown or reddish, instead of chlorotic. This symptom appears to be correlated with the presence of anthocyanin pigment in the leaves.

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[1] Wardlaw, C. W., *Trop. Agric.*, **14**, 10 (1937); **15**, 276 (1938).

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Head Presentation in Indian Chiroptera

MORE than a century ago, Daniell[1] described a head presentation during parturition in *Nyctalus noctula*. This record has been considered unique among bats, since later investigators have not been able to observe a similar birth. Breech presentation has been considered to be the usual rule in Chiroptera, following the observations of Rollinat and Trouessart[2] on *Myotis myotis* (called by them *Vespertilio murinus*), Sherman[3] on *Myotis austroriparius* and more recently by Wimsatt[4] on *Myotis lucifugus* among the Vespertilionidæ, and Blake[5] in a Phyllostomid bat (*Erophylla planifrons* ?).

Anyone who reads Daniell's account might be struck by the novelty of such a birth. I had opportunities of witnessing in detail parturition in the Indian short-nosed fruit bat *Cynopterus sphinx sphinx* (Vahl.), and Schneider's leaf-nosed bat *Hipposideros speoris* (Schn.), and in both a head presentation appears to be characteristic. Daniell's observations on *Nyctalus noctula* does not seem, therefore, to be unique, and since the two species reported above belong to the two different sub-orders of Chiroptera, extended observations may reveal further instances in which head presentation may be the rule.

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Semi-Squamous Epithelial Layer in the Frog

AFTER studying the existence of the semi-squamous epithelial layer in the gastric and intestinal mucosæ of different mammals, we were curious to know if a similar layer was present in the amphibians, and for the purpose of this investigation we chose the frog. In this animal it was found that the whole gastric and intestinal mucosæ, together with the gall bladder, were covered by this layer.

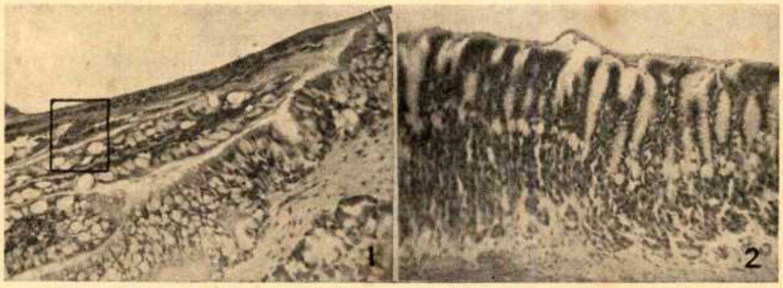

Fig. 1. Œsophagus of frog showing the ciliated tissue covered by the semi-squamous epithelial layer which contains a capillary. Fig. 2. Gastric mucosa of frog showing the layer

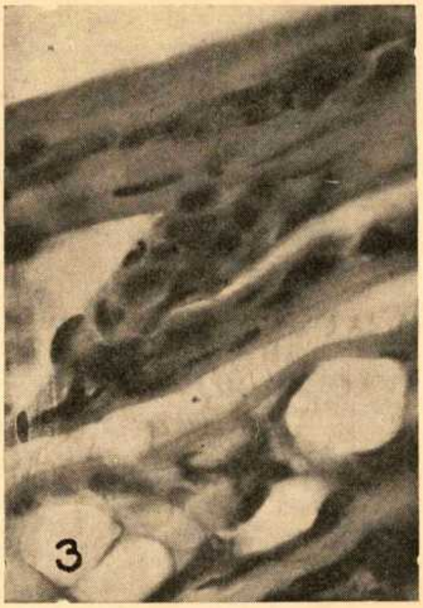

Fig. 3. High magnification of area outlined by rectangle in Fig. 1 showing details of the ciliated tissue covered by the semi-squamous epithelial layer containing a capillary

Investigations were also made to discover if the ciliated tissue in the œsophagus and pharynx of the frog was covered by the layer, as it has already been shown that the respiratory mucous membrane of mammals is protected by this structure. The same can be said of the ciliated tissue present in the Fallopian tubes, although this is rather more difficult to demonstrate because of the difficulty in opening the tubes without destroying the layer. It was logical to expect, therefore, that the semi-squamous epithelial layer should cover the ciliated tissue of the frog.

When this animal is used for the purpose of demonstrating the movement of the ciliated tissue, the layer is always removed beforehand as so-called mucus; but after carefully fixing the mucous membrane of the œsophagus and pharynx by the method of formalin vapour fixation, we were able to show not only that the ciliated tissue is covered by a similar layer to that found in the ciliated respiratory mucous membrane of mammals, but also that there were capillaries present at the top of this tissue.

It is borne in mind that these observations are against the accepted ideas of the physiological mechanism of protection by the ciliated tissue, but in the light of these investigations this supposed function obviously requires some revision.

My thanks are due to Prof. W. Schlapp, of the Department of Physiology, University of Manchester, for the supply of frogs, and to Mr. C. H. Butcher for technical assistance.

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Taste Blindness of Japanese

It is well known that the strongly bitter taste of phenyl-thiourea is not noticed by some persons. It is said that 30 per cent of persons of white race do not recognize the taste. The result of tests on Japanese is given below:

Age	No. of persons examined	No. of 'non-tasters'	Percentage of 'non-tasters'
6–10	65	27	42
11–15	133	48	36
16–20	345	72	21
21–25	96	16	17
26–	277	48	17
Total	916	211	23

The percentage of non-tasting persons is obviously smaller. It depends on the age, but is independent of the sex. In respect of inheritance, we have few data to discuss, but so far have found no 'tasting' child born of 'non-tasting' parents.

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June 25.

Composition of the Gum of *Sterculia setigera*: Occurrence of D-Tagatose in Nature

The method of paper partition chromatography provides a simple micro technique for the separation[1] and estimation[2] of mixtures of reducing sugars, such as result from the hydrolysis of complex polysaccharides. It is possible to obtain an indication of the identity of the separated sugars from a comparison of their *Rg* values[1,3] and their colour reactions when heated with a solution of naphthoresorcinol in 12 per cent hydrochloric acid[4,1], but in some instances the results are inconclusive. For example, fructose (*Rg* 0·13), sorbose (0·11) and tagatose (0·13) possess very similar *Rg* values and all give a characteristic red colour with the naphthoresorcinol reagent, and they cannot, therefore, be identified by these properties alone. The difficulty has been overcome by use of a column of powdered cellulose[5], on which it is possible to separate by partition chromatography sufficiently large quantities of the sugars to permit of their identification in the usual way by determination of physical constants and the formation of characteristic derivatives.

In a study of the gum exudate of the tropical tree *Sterculia setigera*, we have applied these methods to the analysis of the mixture of sugars produced by acid hydrolysis of the polysaccharide.

The gum shows exceptional stability to acids, requiring such drastic conditions for complete hydrolysis that the reaction is accompanied by much degradation of the sugars. Partial hydrolysis of the gum, however, gave, with little degradation, a mixture of sugars and a degraded material which contained the uronic acids. After hydrolysis the free sugars were separated from the uronic acid portion, the properties of which corresponded to those of a trisaccharide containing two D-galacturonic acid residues and a sugar residue, probably mainly L-rhamnose. The chief components of the non-acidic portion were D-galactose, L-rhamnose and a ketose, which, from its properties, could be fructose, tagatose or sorbose. A portion of the sugar mixture (1·6 gm.) was separated on a column of powdered cellulose using as the mobile phase a solution of *n*-butanol saturated with water. After removal of solvent, two of the fractions crystallized spontaneously, and pure specimens of D-galactose and L-rhamnose hydrate were obtained. D-Tagatose was obtained in crystalline form from an intermediate fraction after oxidation of the accompanying aldose to the aldonic acid, which was removed as the barium salt. This sample of D-tagatose from *Sterculia setigera* gum was identical with a synthetic specimen kindly sent to us by Prof. T. Reichstein. Its identity was confirmed by an X-ray comparison of the crystals of the naturally occurring and synthetic sugar. We are indebted to Dr. T. Malkin for these results.

Fraction	Weight (in mgm.)	$[\alpha]_D$ in water	*Rg* values of sugars present	Sugars present
I	15	12°	0·385	Ketose
II	413	9·4°	0·30	L-Rhamnose
III	145	8·0°	0·17; 0·13	Aldose and D-tagatose
IV	373	34°	0·17; 0·13; 0·07	Aldose, tagatose and D-galactose
V	640	80·5°	0·07	D-Galactose

Fraction I contains a ketose which, in view of its high *Rg* value, is in all probability a methyl pentose derivative, and fraction III contains a small quantity of an unidentified aldose. The occurrence of D-galactose and L-rhamnose residues in a plant gum is not unusual, but the presence of D-tagatose in quantity is of particular interest since this ketose has not hitherto been reported as a constituent of any natural product. Its isolation illustrates the power of the new methods of analysis, and it is clear that re-examination of many plant and animal products will be required in order to ascertain whether sugars are present which have hitherto escaped detection.

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Sept. 4.

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[2] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *Nature*, 160, 86 (1947); *J. Chem. Soc.*, 1679 (1948).

[3] Brown, F., Hirst, E. L., Hough, L., Jones, J. K. N., and Wadman, H., *Nature*, 161, 720 (1948).

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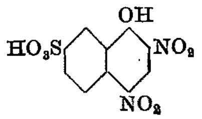
[5] Hough, L., Jones, J. K. N., and Wadman, H., [*Nature*, 162, 448 (1948)].

Adsorption Complexes of α-Zinc Hydroxide

In numerous communications, Feitknecht has described the preparation and structures of the basic salts and hydroxide of zinc. Particular reference is made in this communication to the so-called α-form of zinc hydroxide ($Zn(OH)_2$), to which Feitknecht[1] has ascribed a partially random structure, consisting of an assemblage of parallel layers, packed together without any further regularity. The analogy with the structures of the natural clay minerals montmorillonite and halloysite suggested to one of us (D. M. C. M.) that it would be of interest to see if the α-hydroxide shows the same type of interlayer adsorption as these clays[2]. This appeared likely, because Feitknecht[3] had shown that certain anionic dyestuffs are adsorbed on the α-zinc hydroxide, either by incorporating them in solution during the precipitation, or by shaking it with a solution of the dyestuff.

We have been able to prepare a stable complex of α-zinc hydroxide and the I.C.I. dye Naphthol Yellow



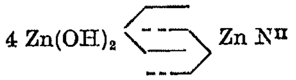
under well-defined conditions, which gives, in the unwashed state, a sharp basal spacing of 24·4 A. A single washing with either water or alcohol is sufficient to reduce this to an equally strong reflexion at 19·6 A. with four orders, which is stable to at least ten washings with alcohol or water, or even 0·001 *N* sodium hydroxide in alcohol. This is referred to below as the 'primary' complex.

Similar attempts to incorporate simpler non-ionized molecules (for example, glycerol) in the α-zinc hydroxide have failed. The analogy with the clay complexes thus appears to break down at this point.

However, it occurred to one of us (O. T.) that the more marked layer structure of the primary complex (clearly shown by the X-ray photographs) may make it more amenable to the adsorption of neutral organic molecules, thus forming 'secondary' complexes with increased basal spacings. Several such complexes, of which a small selection is listed in the accompanying table, have been investigated, using the same technique as has been used by MacEwan[2] with the clay mineral complexes. With the nitriles (except acetonitrile), a preliminary heat treatment was necessary to form the complex.

Substance adsorbed	d_{001} in A.	Δ in A. ($= d_{001} - 19{\cdot}6$)
Water	30·7	11·1
Methyl alcohol	27·8	8·2
Ethyl alcohol	30·8	11·2
Ethylene glycol	29·6	10·0
Glycerol	30·1	10·5
Acetonitrile	23·7	4·1
Propionitrile	25·1	5·5

On the analogy of the constitutional formula assigned by Feitknecht[4] to the basic zinc chloride II, the zinc and carbon contents of the (α-zinc hydroxide)–(Naphthol Yellow) complex agree quantitatively, within the limits of experimental error, with the formula



(in Feitknecht's[5] notation), where N^{II} is the divalent anion of the dye. A comparison of the calculated surface areas of the unit cell of α-zinc hydroxide and the planar dye molecule, together with the observed dye content of the primary complex, suggests that four layers of the dyestuff, lying flat, are held between consecutive layers of hydroxide. This is also in accord with the calculated thickness of the dye molecule, and the observed *c*-spacing of the primary complex.

The extra space taken up by the neutral organic molecules in the secondary complexes suggests that they form layers as in the clay mineral complexes, but the numbers of these layers appear to be different from those in the latter. This is probably due to differences in the actual mechanism of binding; in these 'secondary' complexes the additional molecules may be bound to the organic component of the primary complex rather than to the hydroxide layer. If this is so, it should be possible to prepare complexes presenting surfaces of different natures by employing anionic dyestuffs, the anionic portions of which vary in structure and lie within certain limits with regard to their size. The problem clearly requires a detailed examination, which is now being undertaken, and will form the subject of a later communication.

Prof. Feitknecht, who has seen this communication, informs us that he has since sent a communication entitled "Basische Salze organischer Säuren mit Schichtenstruktur" to *Experientia* (in the press).

We wish to thank Prof. W. Feitknecht for informing us, before publication, of certain of his results, and Messrs. I.C.I., Ltd. (Dyestuffs Division), for free gifts of materials. One of us (O. T.) wishes to thank the Department of Scientific and Industrial Research for a grant which has made his contribution possible.

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[1] Feitknecht, W., *Helv. Chim. Acta*, **21**, 766 (1938).
[2] MacEwan, D. M. C., *Trans. Farad. Soc.*, **44**, 349 (1948).
[3] Private communication.
[4] Feitknecht, W., *Helv. Chim. Acta*, **26**, 1911 (1943).
[5] Feitknecht, W., *Kolloid-Z.*, **92**, 257 (1940).

Reduction Potentials of Conjugated Systems

WAZOWNEK and his collaborators have studied the reduction of conjugated systems at the dropping mercury electrode[1]. They have brought forward evidence to support the following mechanism :

$R + e^- \rightarrow R^-$ (reversible, potential-determining).
$R^- + e^- \rightarrow R^=$ (irreversible).
$R^= + 2H_2O \rightarrow RH_2$ (irreversible, fast).

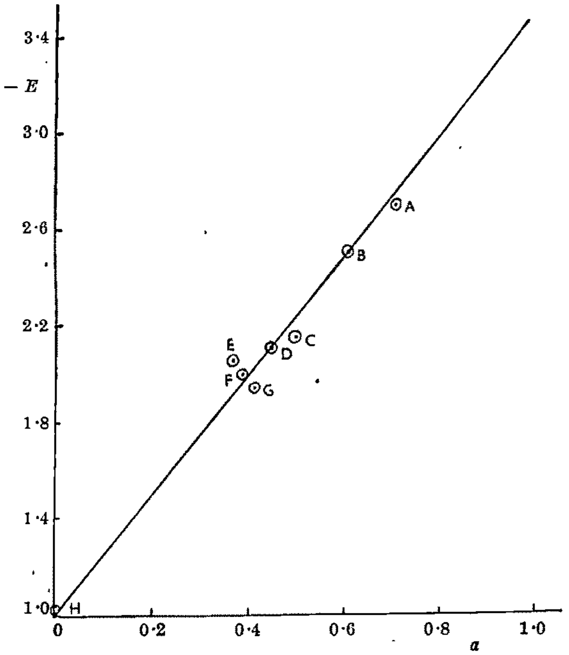
This holds in the case of a molecule such as styrene, having a bond which is essentially double. In the case of aromatic molecules, however, the reversible, potential-determining step may consist in the addition of two electrons.

Hückel[2] has applied the molecular orbital method to a discussion of the alkali metal salts of aromatic compounds. He points out the qualitative relationship between the resonance energy in the lowest unoccupied molecular orbital (which may accept one or two electrons) and the ease of addition of the alkali metals. The present communication shows how this concept may be applied to discuss the reduction potentials of conjugated systems.

The reversible potential is given by

$$-nEF = \Delta H - T\Delta S,$$

where ΔH is the heat content and ΔS the entropy change, n being the number of electrons involved. Now ΔH may be related to the energy required to place one or two electrons in the lowest unoccupied orbital of the molecule, and so there should exist a linear relationship between E and a, where a is the coefficient of the molecular orbital resonance integral in the expression for the energy of the lowest unoccupied orbital. A plot of E against a is shown in the accompanying figure. The approximately linear relationship between E and n verifies the postulated mechanism. Further evidence may be obtained by considering the overall equilibrium between R and RH_2. If this were the potential-determining process, there should exist a relationship between the potential and the difference in resonance energies of RH_2 and R. No such relationship exists.



The reduction potentials of some hydrocarbons as a function of *a*. The substances referred to are: *A*, diphenyl; *B*, naphthalene; *C*, stilbene; *D*, pyrene; *E*, tetraphenyl ethylene; *F*, 1:4 diphenyl butadiene; *G*, anthracene; and *H*, triphenyl methyl.

On the basis of the above theory, the difficulty of reduction of an isolated double bond and of benzene may be understood, for in these cases a very large negative potential would be required. In the former case polarographic reduction differs from catalytic reduction[3].

Reduction by dissolving metals may also be discussed on these lines. Two possible mechanisms exist in this case,

$$R + H^+ \rightarrow RH^+$$
$$RH^+ + 2e \rightarrow RH^-$$
$$RH^- + H^+ \rightarrow RH_2$$

as suggested by Burton and Ingold[4]; or

$$R + 2Na \rightarrow R^= + 2Na^+$$
$$R^= + 2BH \rightarrow RH_2 + 2B^-$$

as proposed by Ziegler[5]. In addition, there is the possibility in the former scheme of the consecutive addition of the electrons. Two problems arise in these cases, namely, the ease of reduction, and the products formed. The former may be discussed along the lines suggested above. For a discussion of the latter, the electron structure of RH^- and $R^=$ will have to be examined. The position of addition of the protons will be determined by the charge distribution of the ions.

It is hoped shortly to publish a fuller account of this work.

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[1] Wazownek *et al.*, *J. Amer. Chem. Soc.*, **64**, 1765, 2365 (1942); **68** 2541 (1946).

[2] Hückel, Int. Conf. on Physics, 9 (London, 1934).

[3] Maccoll, *Nature* [163, 138 (1949)].

[4] Burton and Ingold, *J. Chem. Soc.*, 2022 (1929).

[5] Ziegler, *Z. angew. Chem.*, **49**, 449 (1936). See also, Birch, Faraday Society Discussion on the Labile Molecule, 246 (1947).

Electron Distribution in Substituted Styrenes Derived from Infra-Red Spectra

IN a recent communication[1], it was pointed out that the abnormalities in the physical properties and polymerization characteristics of vinyl mesitylene could be ascribed to steric hindrance by the methyl groups in the ortho positions; it was mentioned that a study of the infra-red spectra of the styrenes revealed differences that supported the hypothesis that this 'blocking' affected the electronic structure.

In the light of recent developments in the normal co-ordinate treatment of group vibrations[2], a more precise interpretation of the infra-red results may now be given. The key δ_{CH_2}-band[2] in styrene lies at 913 cm.$^{-1}$. The shifts from this frequency in *m*- and *p*-methyl styrenes and in 5-vinyl-pseudocumene have values of −5, −4 and −5 cm.$^{-1}$ respectively; the shift in vinyl-mesitylene is + 12 cm.$^{-1}$. The absolute magnitudes of δ_{CH_2} indicate that there is a resultant negative charge on the terminal carbon atom of the vinyl group in all five compounds, which will be associated with *m*-substitution in the phenyl nucleus. The methyl groups in the three compounds with negative increments give rise to a small additional negative charge over and above that due to conjugation with phenyl; presumably the normal effect found in propylene[2] is transmitted via the conjugated system. In vinyl mesitylene, the relative instability of planar structures inhibits the resonance effect, and, in spite of the presence of three methyl groups, the increment is positive, though the electron distribution is still such as to give rise to *m*-direction.

I wish to express my gratitude to Trinidad Leaseholds, Ltd., for allowing me access to the infra-red data used in this note.

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[1] Buck, F. R., Kennedy, G. T., Morton, F., and Tanner, E. M., *Nature*, **162**, 103 (1948).

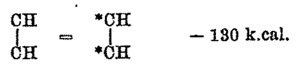
[2] Torkington, P., *Proc. Roy. Soc.* (in the press); *Nature* [162 370 (1948)].

Thermochemistry of Acetylene and Allylene and the Valency of Carbon

RECENTLY, Long and Norrish[1] have shown that when the energy associated with the tetravalent state of carbon is systematically taken into account it is possible to bring order into the thermochemistry of carbon. They support the value of 190 kcal. for the latent heat of sublimation of graphite into free atoms at the lowest energy-level of tetravalence (^5S), and 125 k.cal. for the latent heat of sublimation into the divalent (^3P) state. Thus, the energy obtained in the $^5S \rightarrow {}^3P$ conversion is 65 kcal.

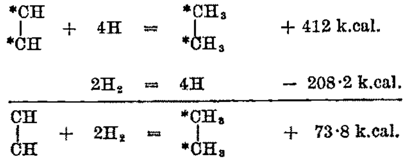
The purpose of the present note is to show that if we assume that in acetylene and derivatives there are two carbon atoms in the divalent state associated with each triple bond, and compute the heat of hydrogenation using this assumption together with the values of Long and Norrish, the result is in striking concordance with the experimental values.

Heat of hydrogenation of acetylene to ethane. Taking the value for the C—H bond energy in ethane[1], and writing *C for tetravalent carbon and C for divalent carbon, we have, assuming divalent carbon in acetylene:



$$\begin{array}{c}\mathrm{CH}\\|\\\mathrm{CH}\end{array} = \begin{array}{c}{}^*\mathrm{CH}\\|\\{}^*\mathrm{CH}\end{array} \qquad -130\ \text{k.cal.}$$

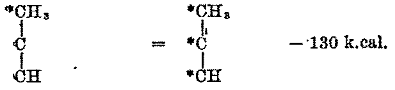
The first step consists in the excitation of the two carbon atoms:



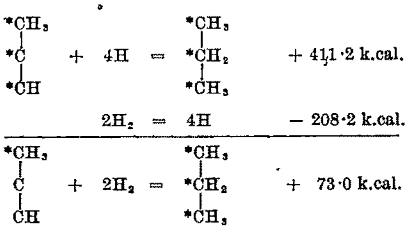
$$\begin{array}{lcl} \begin{array}{c}{}^*\mathrm{CH}\\|\\{}^*\mathrm{CH}\end{array} + 4\mathrm{H} & = & \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{CH_3}\end{array} \qquad +412\ \text{k.cal.} \\ 2\mathrm{H_2} & = & 4\mathrm{H} \qquad -208{\cdot}2\ \text{k.cal.} \\ \hline \begin{array}{c}\mathrm{CH}\\|\\\mathrm{CH}\end{array} + 2\mathrm{H_2} & = & \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{CH_3}\end{array} \qquad +73{\cdot}8\ \text{k.cal.} \end{array}$$

The experimental value for this reaction is + 74·4 k.cal.

Heat of hydrogenation of allylene to propane. Again, using for the C—H bond energy in propane the value 102·8 k.cal.[1], and computing the heat of hydrogenation of allylene, we have:



$$\begin{array}{c}{}^*\mathrm{CH_3}\\|\\\mathrm{C}\\|\\\mathrm{CH}\end{array} = \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{C}\\|\\{}^*\mathrm{CH}\end{array} \qquad -130\ \text{k.cal.}$$



$$\begin{array}{lcl} \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{C}\\|\\{}^*\mathrm{CH}\end{array} + 4\mathrm{H} & = & \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{CH_2}\\|\\{}^*\mathrm{CH_3}\end{array} \qquad +411{\cdot}2\ \text{k.cal.} \\ 2\mathrm{H_2} & = & 4\mathrm{H} \qquad -208{\cdot}2\ \text{k.cal.} \\ \hline \begin{array}{c}{}^*\mathrm{CH_3}\\|\\\mathrm{C}\\|\\\mathrm{CH}\end{array} + 2\mathrm{H_2} & = & \begin{array}{c}{}^*\mathrm{CH_3}\\|\\{}^*\mathrm{CH_2}\\|\\{}^*\mathrm{CH_3}\end{array} \qquad +73{\cdot}0\ \text{k.cal.} \end{array}$$

The experimental value for this reaction is 71·1 k.cal.

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Aug. 4.

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[1] Long and Norrish, *Proc. Roy. Soc.*, A, **187**, 337 (1946).

Phase Characteristics of Exponential Functions

A PHASE relation familiar to students of applied mathematics exists between a simple harmonic oscillation and its derivative. Similar relations exist between exponential functions and their derivatives, but these do not appear to be well known, and are not described in any text-book I have been able to consult: reference is made in some text-books to the imaginary period of the exponential function.

The simplest relation of this type is expressed by

$$\dot{x}_2 = -kx_1,$$

where $x_1 = x(t_1)$, $x_2 = x(t_2)$, and $t_2 - t_1 = c$. Any exponential solution of this equation represents a subsidence, a damped oscillation, a harmonic oscillation, or an unbounded oscillation. The general solution is a sum of such components, and the value of $\varphi = kc$ determines which types may appear in it. In particular, there can be no unbounded component unless $\varphi > \pi/2$; no harmonic component unless $\varphi = \ldots -\frac{3\pi}{2}, \frac{\pi}{2}, \frac{5\pi}{2} \ldots$; and no steadily decreasing component unless $0 < \varphi \leqslant e^{-1}$.

When $e^{-1} < \varphi < \pi/2$, an expression of the form

$$x = X \exp(-At) \cdot \frac{\sin}{\cos}(Bt \pm \theta)$$

may be the solution. If then the interval c is less than the periodic time $2\pi/B$, a derived expression is

$$\varphi = \frac{\gamma}{\sin\gamma} \exp\left(\frac{-\gamma}{\tan\gamma}\right),$$

where $\tan\gamma = B/A$.

The equation

$$\dot{x}_2 = -kx_1$$

may also be regarded as forecasting the behaviour of $x(t)$ for $t \geqslant c$ from its values for $0 \leqslant t < c$. For example, if $x = X$, for $0 \leqslant t < c$, successive integration shows that

$$x = X\left\{1 - \varphi\left(\frac{t}{c} - 1\right) + \frac{\varphi^2}{2!}\left(\frac{t}{c} - 2\right)^2 \ldots \ldots + \frac{(-\varphi)^{n-1}}{(n-1)!}\left[\frac{t}{c} - (n-1)\right]^{n-1}\right\},$$

for $$(n-1)c \leqslant t < nc.$$

This is steadily decreasing only if

$$\varphi \leqslant e^{-1},$$

a fact which is used in the following example.

An air-force formation has been operating N aircraft, the maximum number that its resources suffice to maintain serviceable for an indefinite period, but holds in reserve, at t_0, X serviceable aircraft over and above N. It is intended to operate for a period every serviceable aircraft held. There is evidence that the rate of change of serviceability, $\dot{x}_2$ at t_2, will be proportional to the difference x_1 between N and $(N + x_1)$ the number operated at an earlier time t_1, so that $\dot{x}_2 = -kx$; if $k = 2$ per month, what may be the maximum value of $c = t_2 - t_1$ in months if there is to be no tendency for serviceability to fall below the continuously maintainable, N, level? Answer, c must be $\ngtr e^{-1}/2$ or 0·184 month.

The class of equations to which the above illustrations belong has been discussed generally by H. R. Pitt[1], to whom, and to R. McKinnon Wood and G. Silyn-Roberts, I am indebted for unpublished notes.

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[1] *Proc. Camb. Phil. Soc.*, **40**, Pt. 3, 199 (1944), and 43 (1946).

THE NATURE OF PENETRATING PARTICLES IN AIR SHOWERS

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Introduction

EXTENSIVE air showers consist mainly of electrons and photons, but contain in addition a small percentage of particles more penetrating than electrons.

The nature of these particles was recently discussed by Auger, Daudin, Fréon and Maze[1]; and independently by Broadbent and Jánossy[2]. Both groups came to the conclusion that the penetrating particles cannot be mesons of the ordinary type. Auger's group suggested that the penetrating particles are 'λ-mesons', that is, charged particles of elementary charge and mass about 3 m_e. Broadbent and Jánossy put forward the suggestion that the penetrating particles are 'heavy electrons', that is, electrons of mass about 10 m_e. The two suggestions are, of course, identical; both were, however, based on somewhat indirect arguments. Recent experiments, partly reported at the Bristol Symposium held last September, give additional support to the λ-meson or heavy electron hypothesis.

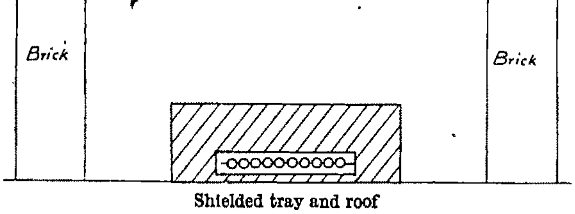
Recent Experimental Evidence

Miss Chowdhuri reported at the Bristol Symposium the following experiment. Air showers were recorded by means of fourfold coincidences. The set consisted of three unshielded counters in a horizontal plane and a tray of shielded counters near by; the tray was shielded by 15 cm. of lead. Fourfold coincidences were recorded both with and without a lead roof 1 cm. thick (supported by 1 cm. of iron) about 30 cm. above the top of the lead shield. The unshielded counters were placed at a sufficient distance from the shielded tray so as not to be affected by the roof. A considerable change of the rate of fourfold coincidences in the presence of the roof was noticed. The actual rates found are given in Table 1.

Table 1. Fourfold coincidences, rate per hour

With roof	0·263 ± 0·037
No roof	0·474 ± 0·053
Difference	0·211 ± 0·064

The above experiment was repeated and confirmed by us in Dublin. Threefold coincidences were recorded between two unshielded trays each of 750 cm.^{2} area and a shielded tray of 1,500 cm.^{2} area. The arrangement of the shielded tray and the roof are illustrated in the accompanying sketch. The roof was supported by 4 in. of wood resting on brick supports. The supports and the wood were left in position throughout the series. Measurements were carried out with various absorbers *A* placed on top of the wood. The results obtained are given in Table 2.



Shielded tray and roof

Table 2

Absorber *A*	No. of coincidences	Rate per hour
No absorber	325	3·32 ± 0·18
20 gm./cm.^{2} brick	231	3·33 ± 0·20
1·7 cm. lead	380	2·53 ± 0·13

We see from Tables 1 and 2 that a thin lead roof reduces the number of penetrating extensive showers recorded, while a mass-equivalent brick roof shows no noticeable effect.

The above experiment can be interpreted, in our opinion, as follows:

(1) The penetrating particles in air showers are produced locally in the first few centimetres of lead.

(2) The penetrating particles are highly unstable and have a considerable chance of decay along the 50-cm. gap between roof and absorber. An apparent life of the order of 10^{-8} sec. is to be expected.

(3) While the thin lead roof shows a considerable effect, no noticeable effect is shown by a mass-equivalent brick roof. It must be concluded that the primaries of the penetrating particles are strongly absorbed in lead but not in the mass-equivalent of brick. This makes it virtually certain that the primaries of the penetrating particles are either electrons or photons or both.

(4) It may be added that this experimental evidence is incompatible with the view that the penetrating particles are produced by nucleons; nucleons would show similar effects in lead and brick roofs. Thus the present experiment further supports the view that the *local* penetrating showers which are produced by nucleons are qualitatively different from the extensive penetrating showers.

The above conclusions, with the exception of (2), were put forward previously by Jánossy and Broadbent[2] as a result of a detailed analysis of shower data.

It should be noted that conclusion (1) stands independently of whether (2) is admitted or not. Though we think it likely that the actual decrease of the shower-rate is caused by decay, this interpretation is not essential for the arguments below; if the decrease were to be explained by any other mechanism (for example, scattering in the roof), it would still be necessary to maintain that the penetrating particles are produced by photons in a thin layer of lead.

Z Dependence of the Production of Penetrating Particles

In discussing the nature of the penetrating particles in air showers, we may recall the experiments carried out by Cocconi and Festa[3], Mura, Salvini and Tagliaferri[4], and Chowdhuri[5]. Extensive showers were recorded in these experiments by counter trays all except one of which were unshielded. The shielded tray was covered alternately with lead only and with lead under an iron shield. As was pointed out by

Ferretti, the number of penetrating events recorded should be proportional to

$$k = \Phi\ (\text{prod}) \,/\, \Phi\ (\text{abs}), \qquad (1)$$

where Φ (prod) is the cross-section for the production of penetrating particles in the top layer of the shield, and Φ (abs) is the cross-section for the absorption of the primaries giving rise to penetrating agents. As shown above, the penetrating agents are produced either by electrons or photons; thus

$$\Phi\ (\text{abs}) \sim Z^2 \text{ per atom.}$$

The comparison of lead and iron absorbers has shown experimentally that Φ (prod) / Φ (abs) is independent of Z. Thus

$$\Phi\ (\text{prod}) \sim Z^2. \qquad (2)$$

Furthermore, it is found that $k \sim 1/50$, and therefore

$$\Phi\ (\text{prod}) \sim \frac{\Phi\ (\text{rad})}{50}, \qquad (3)$$

where Φ (rad) is the 'radiative cross-section'; that is, either the cross-section for *Bremstrahlung* or pair production.

Equations (2) and (3) are most remarkable. They show clearly that the penetrating radiation must be emitted in collisions in the Coulomb field of the nucleus; thus the conclusion can scarcely be escaped that the penetrating particles are either of the two following types:

(*a*) Particles somewhat heavier than electrons, created by photons by pair production.

(*b*) Neutral particles emitted by electrons as a kind of collision radiation.

If the latter hypothesis were assumed, it would be necessary to ascribe to the electron a charge which is the source of the neutral field. The neutral quantum could then be emitted by the electron accelerated in the Coulomb field. Hypothesis (*b*) is, however, rendered unlikely in view of the experiments of Broadbent and Jánossy, where penetrating agents are found to discharge frequently two covered trays (*m*) and (*b*) on top of each other.

We are therefore left with hypothesis (*a*) that penetrating particles in air showers are largely 'heavy electrons' or λ-mesons produced presumably by photons. We may add that the heavy electrons observed must have energies exceeding 200 MeV. as they are capable of penetrating 15 cm. of lead. If their rest energy is of the order of a few MeV., then the *proper life* is estimated to be of the order of $\tau \sim 10^{-11}$ sec.

This short life fully accounts for the absence of cloud chamber evidence (see, for example, Fretter[6]). A track which might possibly be a case of a decaying heavy electron is found in the left-hand bottom corner of a photograph of a penetrating air shower given by Jánossy, Rochester and Broadbent[7]. The particles penetrating a lead plate seen on the same photograph might very well be examples of heavy electrons.

The supposed short life of the heavy electrons throws more light on the analysis by Auger and co-workers[1]. This analysis shows that extensive showers when penetrating lead absorbers behave essentially differently from what is to be expected from cascades. On the other hand, the behaviour of extensive air showers in the atmosphere can be accounted for in terms of the cascade theory, as shown, for example, by Cocconi, Loverdo and Tongiorgi[8]. This discrepancy can be explained in terms of the instability of the heavy electron. The heavy electrons play an important part only in dense absorbers.

Estimate of the Mass of the Heavy Electron

The experiments described above, together with those reported earlier[1,2], seem to show conclusively that at least an appreciable fraction of the penetrating particles in air showers are different in nature from particles observed hitherto. The conclusion that these new particles are, in fact, heavy electrons must be taken only as a conjecture, supported by general theoretical arguments. It seems, however, worth while to show that the assumption of a heavy electron of suitable mass does not lead to contradictions.

In particular, it follows from general arguments that the ratio between the cross-section for production of heavy pairs and the cross-section for collision radiation of a heavy electron must be very nearly the same as the ratio of the corresponding cross-sections for ordinary electrons; we show in the following that the observed effects are compatible with this general assumption.

The cross-section Φ (prod) of equation (1) is the average cross-section for the production of a heavy pair per incident electron. We derive the actual probability for the production of a heavy pair in the following way.

An electron or photon of energy E incident on the absorber gives rise to cascades, and the total photon path-length of photons with energy exceeding E' is

$$t\ (E, E') = 0{\cdot}572\ E/E' \text{ cascade units.}$$

Assuming that the number of photons is 1·5 times the number of electrons in the shower, we have for the total photon path associated with one electron

$$2{\cdot}5\ t\ (E, E') = 1{\cdot}43\ E/E'.$$

The energy spectrum of the air shower can be represented by

$$dS\ (E) \sim \frac{E_c\, dE}{(E + E_c)^2} \quad E_c = 100 \text{ MeV.} \qquad (4)$$

(Mitra and Rosser, in the press; reported at the Bristol Symposium).

Thus the total path-length per incident electron in cascade units is

$$T\ (E') = \frac{1{\cdot}43}{E'} \int_{E'}^{E_1} \frac{E\, E_c\, dE}{(E + E_c)^2} =$$

$$\frac{1{\cdot}43\ E_c}{E'} \left\{ \log \frac{E_1 + E_c}{E' + E_c} - \frac{E_c\ (E_1 - E')}{E_1 + E_c} \right\} \qquad (5)$$

(E_1 is the upper limit of the validity of (4)).

The mean free path of a photon for giving rise to an ordinary pair is 1·35 cascade units; thus the probability P of a heavy pair being produced is about $0{\cdot}76\ T\ (E')\ K$, where $K \sim (m_e/m_h)^2$.

We have to consider the probability that a heavy electron discharges one of the shielded counters. The ionization loss in 15 cm. of lead (30 cascade units) is 200 MeV.; thus only heavy electrons with $E' >$ 200 MeV. need be considered. The probability of a heavy electron $E' > 200$ MeV. traversing the absorber of 30 cascade units is of the order of $\exp\ (-30\, K\ \alpha\ (E'))$, $30\, K$ being the thickness of the absorber in cascade units of the heavy electron; $\alpha\ (E')$ is a function derived from cascade theory, which has values somewhat less than unity for small energies and is decreasing for larger energies.

We have thus for the fraction k of penetrating particles

$$k = 0{\cdot}76\ T\ (200 \text{ MeV.})\ K \exp\ (-30\, K\ \alpha\ (E')).$$

Now putting $k = 1/50$ (equ. 3), $K = 1/30$, $\alpha = 1$, the equation requires $T(E') \sim 2 \cdot 0$. This value is reasonable; it is obtained from (5) by putting $E_1 \sim$ 6,000 MeV. Thus the experimental findings are roughly in accord with $K = 1/30$; that is, $m_h \sim 6m_e$. The above consideration is very rough; but it seems to show that the heavy electron hypothesis is not incapable of accounting for the experimental findings.

We are greatly indebted to Prof. W. Heitler for detailed discussions, and we are also indebted to Dr. T. Nevin for help during the experiments.

Note added in proof. After submitting this communication a photograph purporting to be that of a particle of mass $10\,m_e$ has been reported by Cowan (*Science*, November 12, 1948).

[1] Auger, Daudin, Fréon and Maze, *C.R. Acad. Sci. Paris*, **226**, 169 (1948).
[2] Broadbent and Jánossy, *Proc. Roy. Soc.*, A, **192**, 364 (1948).
[3] Cocconi and Festa, private communication.
[4] Mura, Salvini and Tagliaferri, *Nature*, **159**, 367 (1947); *Att. Acad. Linc.*, **2**, 437 (1947).
[5] Chowdhuri, *Nature*, **161**, 680 (1948).
[6] Fretter, *Phys. Rev.*, **73**, 41 (1941).
[7] Jánossy, Rochester and Broadbent, *Nature*, **155**, 142 (1945).
[8] Cocconi, Loverdo and Tongiorgi, *Phys. Rev.*, **70**, 852 (1946); *Rend. Cont. Sci.*, **77**, 1 (1943).

SIMULTANEOUS MEASUREMENT OF THE OPTICAL CONSTANTS OF METALS OVER A WIDE WAVE-LENGTH RANGE

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THE optical constants of metals can be calculated from a knowledge of the ellipse of vibration which results from the reflexion of plane polarized light usually at an azimuth of 45° by a plane metallic surface. In the present method, this ellipse is determined by finding the ratio of the major and minor axes and the orientation of the major axis to the plane of incidence. It differs, however, from other methods using this principle in that the data from which the ellipse is obtained are produced on a photographic plate in the form of a thin vertical strip of variable intensity for each wave-length. A continuous source and a dispersing prism enable a record to be obtained simultaneously for the whole of the spectrum-range required.

The essentials of the optical system are shown in Fig. 1. The reflected elliptically polarized light passes through the rotator T, which consists of two prisms of right- and left-handed quartz in optical contact. Above the central plane the ellipse will be rotated clockwise; below, counter-clockwise. Fig. 2 indicates the relative orientations of the ellipse in the light emerging from the rotator. If the analysing nicol N is adjusted for plane polarized light, the vibration direction of which is vertical, then in the positions ACF the intensity will be a minimum, and in positions BEG a maximum. The square root of the ratio of these intensities gives the ratio of the axes. DD is the central plane, so that the orientation of the ellipse is given by

$$\theta = \frac{CD}{CF} \times 180°.$$

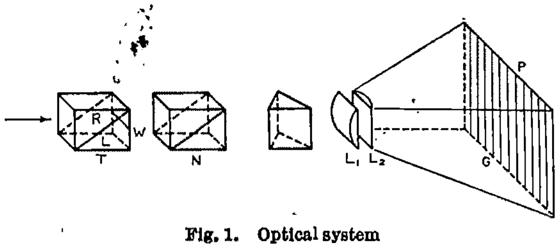
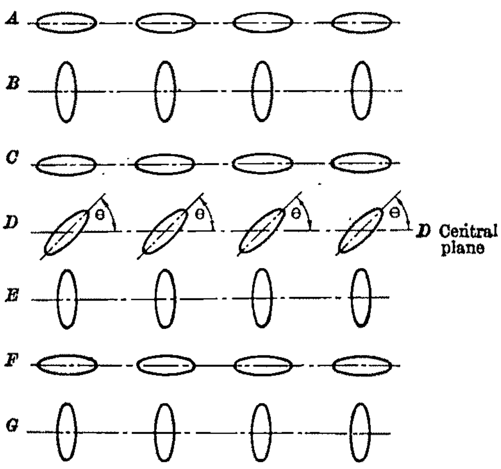


Fig. 1. Optical system



A, C, F, minima; B, E, G, maxima; $BC = AC$
Fig. 2. Relative orientations of the ellipse

A fiducial line consisting of a very fine wire W is placed immediately after the rotator and adjusted to be in the central plane. A plano-cylindrical lens L_1 produces at its conjugate focus P an image of the pattern of Fig. 2, modified by the analyser, and of the fiducial line, magnified in the vertical plane only. A second plano-cylindrical lens L_2 converges the light horizontally into a vertical strip of variable intensity in its focal plane P. Using white light and a prism, a spectrum crossed by a system of dark and bright bands together with the horizontal fiducial line is obtained on a photographic plate placed at P. By removing the rotator and analyser, which are mounted together, and placing in position a triangular aperture with base horizontal and its plane coincident with the fiducial line W, an exposure of graded intensity is obtained. In front of the photographic plate P, which can be moved horizontally in its own plane, a grid G is placed, consisting of alternate opaque and transparent strips. This enables the crossed spectrum and the comparison spectrum of graded intensity to be obtained, adjacent strips being of the same wave-length.

Fig. 3 shows the pattern obtained with aluminium, the exposure time for each spectrum, taken consecutively, being 40 sec. Microphotometric comparison of the maxima and minima against the adjacent graded intensity enables the ratio of the axes to be determined, while the distance between the fiducial line and the various maxima and minima gives the orientation of the ellipse. Since the time involved in obtaining the data for a wide wave-length region is so short, the method is clearly advantageous in that deterioration or change of the surface while observations are being made is avoided. So far as we are aware,[5] all existing methods of measuring the optical constants of metals require the use of monochromatic light, making the determination of a dispersion curve a lengthy process.

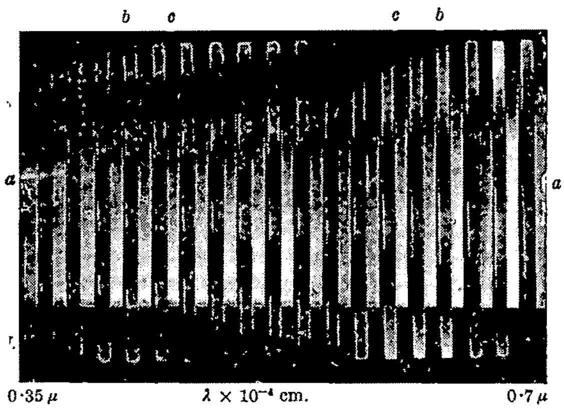


Fig. 3. (a) Fiducial line; (b) vertical bands of variable intensity; (c) adjacent graded intensity

Experiments have so far been carried out in the wave-length range 0·35–0·7 μ with gold and aluminium specimens of known dispersion (measured on the senior author's photo-electric apparatus[1]), and good agreement was obtained. The estimated accuracy is about 2 per cent, but improvements now being made are expected to increase the accuracy and reduce the exposure time.

One of us (B. G. C.) is indebted to the Department of Scientific and Industrial Research for the award of a maintenance grant.

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[1] Bor, *Nature*, **139**, 716 (1937). Bor, Hobson and Wood, *Proc. Phys. Soc.*, **51**, 932 (1939).

GROUND SUBSTANCE OF THE MESENCHYME AND HYALURONIDASE

A CONFERENCE devoted to the "Ground Substance of the Mesenchyme and Hyaluronidase" was organised by Dr. F. Duran-Reynals with the co-operation of Dr. E. D. Goldsmith and was held during December 3–4 under the sponsorship of the New York Academy of Sciences.

The programme concerned itself with all phases of current research pertaining to acid mucopolysaccharides and hyaluronidase, the most important of the group of substances known as spreading factors. Histochemical, electron microscope, biochemical, bacteriological, endocrinological and clinical findings were reported.

Hyaluronidase is widely distributed in Nature. It is found in male germ cells, in pathogenic bacteria, such as streptococci and pneumococci, in insects, in fishes, and in the poison glands of several venomous reptiles. Although produced by such diverse organisms, the function of the enzyme is the same in all cases; but the results are totally different. The function of hyaluronidase is to attack the cementing mucoid substance of the connective tissue. By attacking this cementing substance, the enzyme 'dissolves' it and opens the way for any material which may penetrate the body with it.

Thus, the spreading factor associated with the male germ cells dissolves the cementing material surrounding the female germ cells and makes fertilization possible. (The adhesive quality of mucopolysaccharides of ovarian follicular fluid clumps the granulosa cells around the discharged ovum until acted upon by hyaluronidase from the sperm.) When the factor comes from a bacterium it facilitates invasive infection, and when hyaluronidase is injected with a therapeutic agent, it speeds and enhances the action of such agents.

The study of the action of the enzyme on the cement substance has served to explain an important factor in the mechanism of infection, namely, spreading in the organism of poisons or infectious agents. Equally it has provided a tool for the clinician, since it promotes the spreading of therapeutic substances in the organism. Infections may thus be fought with their own weapons.

The following papers dealing with more specific aspects were read at the conference.

The enhancement of the capacities for growth and invasion of a mouse transplantable squamous cell carcinoma by the local injection of hyaluronidase from testis (W. L. Simpson, Detroit Institute of Cancer Research).

The facilitation of absorption of subcutaneously injected lactate–sodium-glucose solutions with a diminution in pain. It should prove to be extremely useful in hypodermoclysis (C. L. Burket and P. Gyorgy, University of Pennsylvania).

Hyaluronidase enhances the penetration as well as the spreading of drugs. Further, it exhibits very low toxicity (J. Seifter, Wyeth Institute of Applied Biochemistry).

Hyaluronidase reported to be effective in the spreading of the anæsthetic action of local anæsthetics. Certain difficulties encountered in nerve block techniques in regions like the mandible may be overcome by the addition of hyaluronidase to the procaine–epinephrine mixture (C. H. Kirby, J. P. Looby and J. E. Ekenhoff, School of Medicine and Dentistry, University of Pennsylvania).

Dr. D. H. Sprunt (University of Tennessee) and Dr. M. Lurie (Henry Phipps Institute) emphasized the importance of the connective tissue ground-plasm in infection (tuberculosis, D. Lurie). Female sex hormone increases the turgidity of the connective tissue elements and reduces capillary fragility. Œstrogens retard the progress of tuberculosis, chiefly by reducing the permeability of the connective tissue, whereas gonadotrophin enhances the progress of the disease, primarily, by increasing the permeability. It is noteworthy that some years ago Thomas and Duran-Reynals accelerated the progress of tuberculosis with hyaluronidase.

Additional findings by Drs. F. Duran-Reynals, G. Van Wagenen, H. Bunting and J. Opsahl (Yale University School of Medicine) pertaining to the relationship between the œstrogens, adreno-cortical hormone and the ground substance and hyaluronidase were reported.

Drs. C. Ragan and K. Meyer (College of Physicians and Surgeons, Columbia University), in their report on the possible connexion between hyaluronidase and rheumatic diseases, disclosed that the pathogenesis of the rheumatic diseases is obscure. Apparently, the disease process is localized in the connective and particularly in the interfibrillar material, which is composed in part of one or both of the mucopolysaccharides—chondroitin sulphuric acid and hyaluronic acid. Many micro-organisms produce hyaluronidase; but only two, Group *A* and *C* hæmolytic streptococci, produce hyaluronic acid. The highest concentration of hyaluronic acid in the mammal is found in the synovial fluid (in the joint). In normal human joint fluid the hyaluronic acid exists in a highly polymerized form; in rheumatoid arthritis, the hyaluronic acid is depolymerized, and the extent of depolymerization varies with the activity of the disease process.

Dr. M. C. Chang and Dr. N. T. Werthessen (Worcester Foundation for Experimental Biology) took issue with the conclusions of Dr. Raphael Kurzrock to the effect that hyaluronidase is a valuable adjunct in the treatment of infertility. Dr. Chang and Dr. Werthessen attributed Dr. Kurzrock's success to his excellent timing in determining the date of ovulation.

The conference closed on the note that the spreading substances and ground-plasm are of great significance. Much remains to be ascertained; and a uniform system of units should be devised.

E. D. GOLDSMITH

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING

THE forty-sixth annual meeting of the Science Masters' Association was held during January 4–7 in London, at the Royal College of Science. Prof. F. R. Winton, University College, London, in the presidential address on "Specialization", suggested reasons for the undue specialization of school science, contending that boys are driven by a sense of insecurity into scientific studies in their search for truth, but in these studies they seldom meet with experience in the selection and recognition of the vital factors in a problem; and, further, one of the most important approaches, the statistical method, is neglected. Turning to a more detailed consideration of biology teaching, Prof. Winton criticized its subject-matter as being too often narrow and unrelated to human experience; he made a plea for more experimental work in human physiology, and proposed that reform might be brought about through a review of school courses by joint action of the Science Masters' Association and the Biological Council, with medical and psychological representatives.

On the subject of "Phase Contrast Microscopy and the Study of the Living Cell", Dr. Arthur Hughes, after an admirably simple account of the underlying principles, explained how this new technique has made possible the direct study of living cells in tissue cultures. Remarkable results, such as the identification of chromosomes in the resting stage and the formation of tetraploid nuclei, were illustrated by Dr. Hughes' own film of cell division in the spleen cells of the mouse.

In a lecture on "Why Schools should use M.K.S. Electrical Units", Prof. G. H. Rawcliffe pointed out that there is no justification for the present complexity of electrical units. This complexity arose because those who first suggested the units did not realize that the systems involved the permeability and the permittivity of air in addition to the centimetre, gram and second. The simplest unified system is the Metre–Kilogram–Second system, which erects the volt, the ampere and the units dependent on them into an absolute system; this has the advantage of being the system that electrical engineers use, and prevents the confusion between B and H in magnetism and that between D and E in electrostatics.

Sir Charles Goodeve discussed the "Making of Iron and Steel". He referred to the huge amounts of ironstone, coke, limestone and other raw materials used yearly for this purpose, and the selection and control of these by scientific methods. But the human intake which parallels this often lacks preparation, not only in knowledge of the elementary principles of the industry, but also in knowledge of the extremely wide range of trades, crafts and skills that the industry needs to keep it in operation.

The lecture on "The Perception of Light and Colour", by Dr. W. D. Wright, was illustrated by a wealth of demonstrations. Simple experiments were described in which the sensitivity of the eye to light could be compared under various conditions, and the phenomena used, if required, to introduce the idea both of the adaptation of the organism to its environment in biology and the quantum nature of light in physics, as well as the practical problems of vision involved in night flying, driving at night, etc. A method of approach was suggested by which instruction about colour by the art master might be co-ordinated with that by the science master.

Prof. E. D. Hughes, of University College, London, introduced his lecture on "Recent Theories of Organic Chemistry" with a general survey of the application of modern valency theory to problems relating to the structure and reactions of typical groups of organic compounds. Ideas on partial ionic character and resonance hybrids provided explanations of apparently contradictory results of hydrolysis of esters and the reactions of carbonyl and carboxylic groups.

Dr. B. Wheeler Robinson, superintendent of the Physics Division of the National Physical Laboratory, in dealing with "Physics at the N.P.L.", explained how this Laboratory has responsibility for the maintenance of physical standards, for special tests and investigations for the benefit of industry, and for original research arising therefrom. The Physics Division, one of ten divisions which comprise the Laboratory, deals mainly with radiology, heat measurements and acoustics. The measurement of the temperature of molten steel and the thermal conductivity of a building panel were described in more detail, and Dr. Robinson showed how the methods in practice differ from the text-book accounts of them.

"English in the Science Course" formed the subject of a lecture by Dr. D. C. Collins. He pointed out that style is not extraneous ornament; it comes from clear thinking. Words are important to the scientific man as a means by which he explains to 'everyman' the scientific picture of the material world. The difficulty of using words, which is a modern phenomenon, is perhaps due to the decay of the study of the classics, which, *inter alia*, gave a training in the writing of English, and modern courses in English have not completely taken the place of the study of the classics. Dr. Collins suggested possible ways of remedying the deficiency and developing the required skill of writing.

Dr. E. A. R. Ennion described various methods in use at Flatford Mill Field Centre, where he is warden, for the training of students in field-work of all kinds (natural history, geography, local history and rural surveys) and for the initiation and promotion of amateur research. Student groups covered comprise teachers themselves, training college and fifth or sixth form school classes coming with or without teachers and either individually or as corporate parties. The basic assumption was that there is a place for properly conducted amateur research. It is quite feasible for students to acquire the necessary competence provided they are intelligently taught to observe and investigate rather than to listen and collect.

Other meetings included a lecture demonstration by the Gramophone Company on "Sound Recording and Reproduction"; different types of recording apparatus were dealt with and some of the difficulties met with were discussed. A discussion on "The Social Sciences in the Grammar School" was opened by Mr. K. G. Collier, of Lancing College. Points covered were the social sciences as the science of human nature and human society; the emergence of a synthesis of views in this field; the potential educational value of the social sciences for integrating the sixth form curriculum, showing the nature and potentialities of scientific method to arts students and conveying to science students the special adaptation and limitations of scientific method in the human sphere.

The exhibitions of apparatus and books attracted much attention, and the members' exhibition revealed once again this year the considerable thought and ingenuity which are being brought to bear on the teaching of science in secondary schools in Great Britain. The apparatus due to Mr. F. A. Meier (Institute of Education, University of London) formed the major contribution—more than forty items, ranging over many branches of physics; some, like the apparatus for making spiral springs, appealed on account of usefulness; others, like the home-made biprism and Fresnel mirrors, were remarkable for their simplicity; but all reflected the genius of their author.

DEFINITION OF THE PLIOCENE–PLEISTOCENE BOUNDARY

THE question of defining the Pliocene – Pleistocene boundary has become important in recent years, because the practices of different geologists have varied to such an extent that deposits described in one publication as Lower Pleistocene may, in fact, be of the same age as deposits elsewhere called Upper Pliocene. A similar problem is presented to geologists and palæontologists at the boundaries of other geological systems; but the problem of where best to draw a boundary between Pliocene and Pleistocene is one which concerns also prehistorians and anthropologists.

At the eighteenth session of the International Geological Congress, one section devoted itself to the discussion of this topic. Opinions of geologists, palæontologists and prehistorians from many different countries were expressed, and there appeared to be a wider measure of general agreement than had been expected. While these discussions were taking place, the Council of the Congress appointed a temporary commission to advise on the question. The following served as members of the Commission: Prof. Kirk Bryan (United States), Prof. G. Dubois (France), Dr. A. T. Hopwood (Great Britain), Prof. W. B. R. King (Great Britain), Dr. L. S. B. Leakey (Kenya), Prof. C. I. Migliorini (Italy), Dr. K. Milthers (Denmark), Dr. Hallam L. Movius, jun. (United States), Dr. K. P. Oakley (Great Britain), Dr. L. L. Ray (United States), Prof. I. M. van der Vlerk (Netherlands), Dr. D. N. Wadia (India), Prof. D. M. S. Watson (Great Britain), Mr. E. J. Wayland (Bechuanaland), Prof. F. E. Zeuner (Great Britain).

At the conclusion of the meetings, the Council of the Congress accepted the recommendations of the Commission, which were as follows:

(1) The Commission considers that it is necessary to select a type-area where the Pliocene – Pleistocene (Tertiary – Quaternary) boundary can be drawn in accordance with stratigraphical principles.

(2) The Commission considers that the Pliocene – Pleistocene boundary should be based on changes in marine faunas, since this is the classic method of grouping fossiliferous strata. The classic area of marine sedimentation in Italy is regarded as the area where this principle can be implemented best. It is here, too, that terrestrial [Continental] equivalents of the marine faunas under consideration can be determined.

(3) The Commission recommends that, in order to eliminate existing ambiguities, the Lower Pleistocene should include as its basal member in the type-area the Calabrian formation (marine) together with its terrestrial [Continental] equivalent, the Villafranchian.

(4) The Commission notes that, according to evidence given, this usage would place the boundary at the horizon of the first indications of climatic deterioration in the Italian Neogene succession.

From the papers read in the section of the Congress devoted to this topic, which are being summarized in the *Geological Magazine*, it is clear that this definition has wide application.

The following table indicates what we consider to be its implications in parts of Europe.

	Italy		Netherlands*		East Anglia*	Human culture
			continental	*marine*		
Lower Pleistocene	Sicilian (*sensu stricto*)		Lower Brabantian Tiglian	Icenian	Wey-bourne Crag Norwich Crag	Abbevillian
Lower Pleistocene	Villafranchian	Calabrian I, II	Pretiglian	Amstelian	Upper part of Red Crag (Butleyan)	Pre-Abbevillian ?
Pliocene	Upper-most part of Astian		Reuverian	Poederlian	Middle part of Red Crag (New-bournian)	

* Based on a paper submitted by Prof. I. M. van der Vlerk (Netherlands).

This table is based on studies of the faunas of shallow-water marine deposits, and of their continental equivalents where known. The Villafranchian is characterized by a fauna which includes *Elephas, Equus* and advanced bovines. This fauna is widespread and has been used for correlating deposits of the same age in different continents. Thus, the apparent equivalents of the Villafranchian are as follows: in Africa, the Kageran beds (with Pre-Abbevillian pebble-tools); in India, the Pinjor stage of the Upper Siwaliks; in China, the Nihowan stage; in Java, the Djetis beds; and in the Central Plains of North America, the Blanco beds.

While it is evident that the Calabrian stage corresponds with the onset of cool conditions in the type-area, correlation with the glacial sequence in the Alps is not yet agreed. Thus, Dr. R. Selli and Dr. G. Ruggieri, in their paper submitted to the Congress, on the Plio-Pleistocene stratigraphy in Emilia (northern Italy), claim that the Calabrian stages I and II are probable equivalents of the Günz and Günz–Mindel stages of the Alpine sequence, and that the Sicilian (*sensu stricto*) corresponds with the Mindel glaciation. On the other hand, a more widely held view is that the drop from the Sicilian high sea-level was brought about by the first major glaciation (Günz). On this latter reading of the data, the basal or Villafranchian division of the Lower Pleistocene is in large part older than the first important growth of ice-caps, and corresponds with the climatic deterioration which was marked in the Alps, for example, by the Donau phases of glacier-growth. Judging from the great thickness of deposits accumulated during the Villafranchian stage, it was of considerable duration.

W. B. R. King
K. P. Oakley

LOCUST BEHAVIOUR AND AIRCRAFT SPRAYING

AERIAL spraying has for long seemed to offer the only means of attacking swarms of winged locusts, and an article in *Nature* of March 6, 1948, outlined the history of the latest attempt to develop this method. "We set out", wrote Dr. D. L. Gunn in that article, "systematically to find whether aircraft methods are applicable to locust destruction and to work out where and when they may compete in effectiveness and in cost with other methods"—something that had not been done before. The full story of the attempt is now appearing; the two present publications*† show how formidable the task was and indicate the very remarkable level of team-work achieved among the entomologists, physicists, chemists, meteorologists and airmen who were involved.

The object of the behaviour studies on the desert locust in Kenya* was to discover what governed the time a swarm remained on its roosting site before flying away in the morning, since it was against roosting swarms that spraying operations were then contemplated. Swarms were watched on seventeen mornings, with simultaneous intensive recording of air temperature, humidity, locust body-temperature, radiation and wind. The start of 'stream-away', when the locusts moved off *en masse*, was usually quite sudden. Among all the factors measured, only the air temperature showed some consistency at this time on different days (*Nature*, **156**, 628; 1945). Apart from its possible practical value, this finding raises interesting physiological and behavioural questions, which are discussed. In seeking for an explanation for the variations in the air temperature at stream-away, a correlation was found between that temperature and the previous day's maximum temperature. The latter is regarded as a measure of the general temperature conditioning to which the insects had been exposed, and it is suggested that a form of physiological temperature adaptation may be involved.

The authors succeeded in tracing the roost-to-roost displacements of a single swarm for eighteen consecutive days. The swarm showed an over-all trend northwards, but zig-zagged a good deal. The displacements of a second swarm were roughly consistent with its being carried by the wind. This type of information on insect migration is very rare, and does not support the idea that migrants drive on undeviatingly towards a hypothetical goal.

The spraying trials against roosting red locusts in Tanganyika† demonstrated the inferiority, for this purpose, of the traditional method of trying to fly low enough during spraying to minimize the spray-drifting action of the wind, as compared with the method, new to insecticide work, of flying at a height calculated to use the existing wind to give the desired spray pattern on the ground. 20 per cent dinitro-*ortho*-cresol (DNOC) solution in oil proved so effective, with complete mortality at about one gallon per acre, that it was used in an intensive series of practical operations, 3,700 gallons being sprayed on a total of 3,335 acres. The authors are cautious; but it appears that their operations may well have averted a serious outbreak of the red locust.

By unexpected good fortune, the swarms were virtually stationary during the campaign. The work would have been very much more difficult had they migrated every day. After giving some estimates of costs, the authors suggest that roosting swarms might be tackled more economically with ground machinery, but that aircraft might be more efficient against flying swarms than against roosting ones.

Both publications contain a mass of factual material on subjects which have had little such foundation hitherto, including detailed estimates of locust numbers and densities made by photographic and other methods.

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* "Behaviour of the Desert Locust (*Schistocerca gregaria* Forskål) in Kenya in relation to Aircraft Spraying." By Dr. D. L. Gunn, F/O. F. C. Perry, F/Lt. W. G. Seymour, F/Lt. T. M. Telford, AC/2 E. N. Wright and D. Yeo. (Anti-Locust Bulletin 3.) Pp. 70+8 plates. (London: Anti-Locust Research Centre, British Museum (Natural History), 1948.) 8*s*.

† "Locust Control by Aircraft in Tanganyika: an Experimental Campaign with BHC (Benzene Hexachloride) and DNOC (Dinitro-*ortho*-cresol) Solutions against Adult Red Locust, *Nomadacris septemfasciata* (Serv.), in an Outbreak Area, the Rukwa Valley, from August to November, 1947." By Dr. D. L. Gunn, H. A. F. Lea, D. H. Botha, S. Callaway, J. R. Clackson, A. Immelman, J. J. Taljaard and J. Ward. Pp. 153+10 plates. (London: Anti-Locust Research Centre, British Museum (Natural History); Pretoria: Locust Control and Research Centre, Department of Agriculture, 1948.) n.p.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 31

Institution of the Rubber Industry, Leicester Section (at the College of Art and Technology, Leicester), at 7 p.m.—Dr. C. M. Blow: "Latex".

Institution of Electrical Engineers, Cambridge Radio Group (joint meeting with the Cambridge University Wireless Society, at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Mr. L. A. Moxon: "Noise and Band Width".

Tuesday, February 1

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. R. Ogilvie Buchanan: "Some Geographical Aspects of the Economic Development of New Zealand".* (Further Lecture on February 8.)

University of London (in the Department of Civil, Mechanical and Chemical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. A. H. Willis: "The Mechanical Properties of Matter".* (Further Lecture on February 8.)

Wednesday, February 2

University of London (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Sir George Stapledon, F.R.S.: "The Ecology of Food Production".*

University of London (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "The Application of Atomic Piles in Nuclear Physics".* (Further Lectures on February 9 and February 16.)

Royal Microscopical Society, Biological Section (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Mr. O. D. Standen: "Some Biological Aspects of Experimental Schistosomiasis".

Manchester Metallurgical Society (joint meeting with the Iron and Steel Institute, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Glen: "Precipitation Hardening Effects in Relation to High Temperature Testing".

Society of Chemical Industry, Food Group (joint meeting with the Portsmouth and District Chemical Society, in the Portsmouth Municipal College, Portsmouth), at 7 p.m.—Dr. L. H. Lampitt: "Food Science in Evolution".

Society of Public Analysts and other Analytical Chemists (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, February 3

Royal Society of Arts, India, Pakistan and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. W. A. M. Walker: "The Growth of the Jute Industry in India and Pakistan".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Electrical Engineers, Supply Section (joint meeting with the Institution of Civil Engineers, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Headland: "Tidal Power and the Severn Barrage". (To be repeated on Monday, February 7, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.; on Monday, February 14, at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.; on Monday, March 7, at the Liverpool Royal Institution, Colquitt Street, Liverpool, at 6.30 p.m.; on Wednesday, May 4, at the Harris Institute, Preston, at 6.45 p.m.; and on Wednesday, May 18, at the Wedgwood Café, Albert Road, Bournemouth, at 6.30 p.m.)

University of London (in the Architecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. J. R. N. Stone: "The Role of Measurement in Economics" (Newmarch Lectures).* (Further Lectures on February 10, February 17 and February 24.)

Institution of Civil Engineers, North-Western Association (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. E. De Courcy Hamilton: "Economic Survey as applied to Civil Engineering".

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Messrs. A. Levin, Harley and Davidson: "The Design Characteristics of Marine Radar Equipment".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Mr. R. P. Bell, F.R.S.: Johannes Nicholas Bronsted Memorial Lecture.

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. W. Harrison and Mr. H. Hewitt: "Artificial Daylight—a new Colour Matching Unit".

Friday, February 4

Institution of Chemical Engineers, North-Western Branch (at the Town Hall, Manchester), at 2.15 p.m.—Annual General Meeting; Dr. F. A. Freeth, F.R.S.: "The Place of Heterogeneous Equilibrium in Chemical Engineering".

Physical Society (in the Physics Department, University College, Gower Street, London, W.C.1), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Leaves".

Saturday, February 5

British Glaciological Society (in the Department of Geography, Cambridge), at 8.15 p.m.—Dr. H. Godwin, F.R.S.: "Pollen Analysis of Glaciers in special relation to the Formation of Various Types of Glacier Bands".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physics—The Principal, Acton Technical College, High Street, Acton, London, W.3 (February 5).

Research Organiser in Education, and an Organiser of Teachers' Library and Information Service—The Registrar, University College, Leicester (February 5).

Assistant in the Medical Department to be Sub-Editor of the *British Medical Bulletin*—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (February 5).

Lecturer in Mechanical Engineering, and a Lecturer in Mathematics—The Principal, Heriot-Watt College, Edinburgh (February 8).

Principal Scientific Officer to lead a team developing specialized techniques for investigating the physical and mechanical properties of irradiated and non-irradiated metals and alloys, a Principal Scientific Officer to lead a team developing laboratory-scale fabrication techniques and in testing methods applicable to rare metals, a Principal Scientific Officer or Senior Scientific Officer for work on general metallurgical problems of piles, a Principal Scientific Officer or Senior Scientific Officer for powder metallurgy, a Senior Scientific Officer to lead a team developing radioactive tracer techniques applicable to metallurgical problems, a Senior Scientific Officer to lead a team developing techniques for fabrication of rare metals, a Senior Scientific Officer to lead a team developing and adapting techniques for the physical and mechanical testing of rare metals, a Senior Experimental Officer or Experimental Officer to take charge of metallographic section, and an Experimental Officer for metallographic section, at the Atomic Energy Research Establishment, Harwell—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2394 (February 8).

Mechanical and Electrical Engineer in the Prison Commission—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2371 (February 10).

Economic Mining Geologist to make a survey of the known mineral resources of Burma, Geologists for the Geological Department, and an Economic Statistician to take charge of the Statistical Department under the National Planning Board—The First Secretary, Burmese Embassy, 19a Charles Street, London, W.1 (February 11).

Post-graduate Research Studentship in Veterinary Parasitology, and a Research Assistant in the Department of Zoology—The Registrar, The University, Liverpool (February 12).

Lecturer in the Department of Chemical Pathology—The Professor of Chemical Pathology, King's College Hospital, Denmark Hill, London, S.E.5 (February 12).

District (Forest) Officers—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (February 15).

Assistant Lecturer in Chemistry—The Registrar, University College, Singleton Park, Swansea (February 24).

Lecturer (ungraded) in Farm Animal Medicine, a Lecturer (ungraded) in Veterinary Physiology, a Lecturer (ungraded) in Veterinary Biochemistry, and an Assistant Lecturer (Grade III) in Veterinary Anatomy—The Registrar, The University, Liverpool (February 28).

Biochemist and a Physical Chemist for the Atlantic Fisheries Experimental Station, Halifax, Nova Scotia—The Executive Director, Fisheries Research Board of Canada, Department of Fisheries, Ottawa, Canada (March 1).

Lecturer in Physics in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (March 1).

Readership in Taxonomy in the Department of Botany at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 2).

Head of the Department of African Studies in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (March 19).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology, Physics or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Forest Mensuration Officer, Silviculturists (one for northern temperate softwoods silviculture, one for genetics research in northern temperate softwoods, and one for indigenous forest ecology and silviculture), a Forest Entomologist, a Timber Technologist specializing in kiln and chemical seasoning, and a Timber Technologist specializing in plywood and laminated construction, in the N.Z. State Forest Service—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 30).

Turner and Newall Research Fellowship in Engineering, Inorganic Chemistry, Physics or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Senior Lecturer (Grade I) in the Department of Physics—The Registrar, The University, Liverpool (May 1).

Research Chemists to engage in research on coal tar at the Research Station, Gomersal, Yorkshire—The Director of Research, Coal Tar Research Association, 9 Harley Street, London, W.1.

Technician (Grade III), having a pathological background, in the Department of Genetics—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Genetics/1'.

Botanist (Plant Breeder) in the Department of Agriculture, Nyasaland—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

Technical Assistant (male or female) at the Medical Research Council's Radiobiological Research Unit, Harwell—The Director, Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Research Engineer or Physicist to carry out investigations on mechanical and electrical problems connected with the dyeing and finishing of textiles—The Research Manager, British Cotton and Wool Dyers' Association, 351 Lower Broughton Road, Salford 3.

Technician (Grade B), with histological experience, in the Department of Surgery—The Secretary, Marischal College, Aberdeen.

Mineralogical Chemist in the Geological Division of the Lands and Mines Department, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Laboratory Technician as biochemical research technician in the Department of Dental Medicine—Prof. M. A. Rushton, Guy's Hospital Dental School, London Bridge, London, S.E.1.

Assistant Professor who is an honours graduate in Mechanical Engineering, and Lecturers (2) with honours degree in Mathematics at the Royal Naval College, Greenwich—The Secretary, Admiralty (C.E. Branch 1), London, S.W.1.

Research Technician for histological work and other duties—The Director, Department of Surgery, Guy's Hospital, London Bridge London, S.E.1.

Administrative Director of the Department of Technology, and an Administrative Assistant—The Secretary, City and Guilds of London Institute, Gresham College, Basinghall Street, London, E.C.2.

Laboratory Technicians (one Senior and one Junior)—The Secretary, Northallerton Hospital Management Committee, Friarage Hospital, Northallerton, Yorks.

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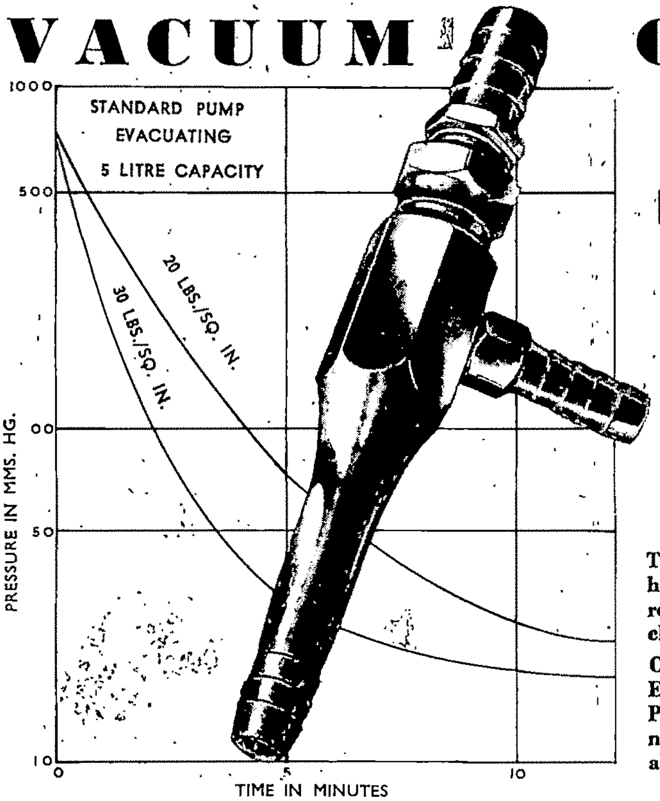

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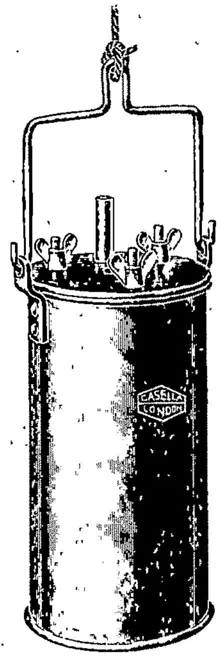

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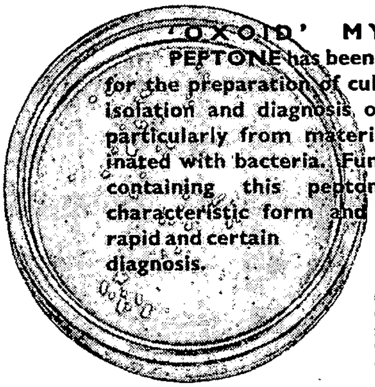

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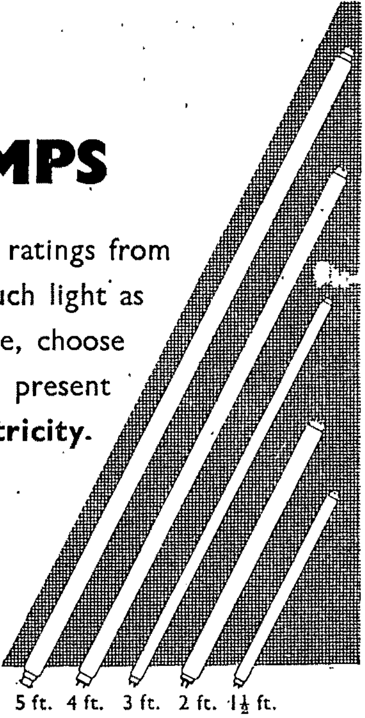
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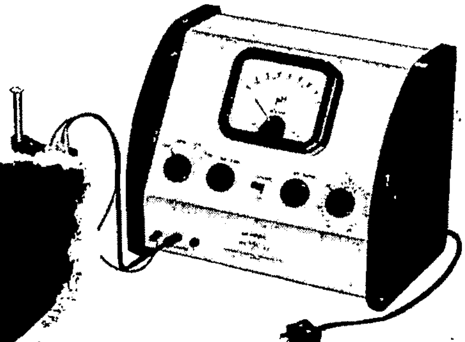

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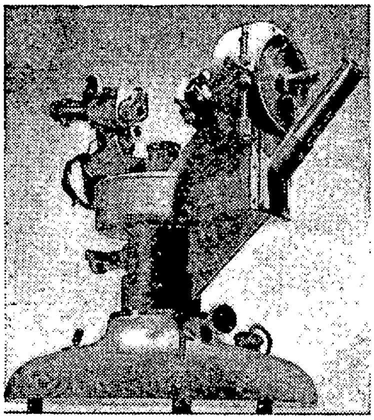

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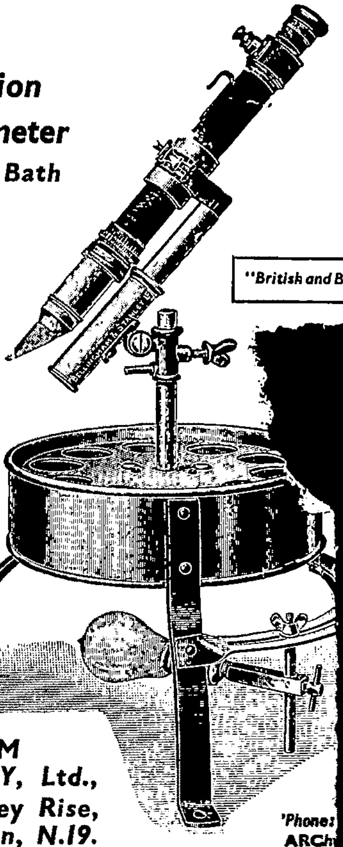

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NATURE

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HUMAN RIGHTS AND PEACE

DURING the first autumn of the Second World War a Declaration of Human Rights was drafted by Mr. H. G. Wells, who suggested that it should be adopted as a statement of Allied aims and an expression of the spirit in which we face life in general. More than nine years later the essence of the ten clauses proposed by Mr. Wells has found expression in the thirty articles of the Charter of Human Rights adopted by the General Assembly of the United Nations in Paris on December 10. Much that has happened in the interval has engendered a certain scepticism as to the value of what can equally be described as a Declaration of Peace Aims. The long debates and discussions of the past two and a half years which have issued in the Charter seem at times to encourage the view that it is essentially a manifesto of ideological warfare expressing the ideals and beliefs of Western civilization.

Any such cynicism should be checked by the realization that no government in existence, even in the Western world, is able to guarantee to all its citizens all the rights laid down. These rights are proclaimed for everyone without distinction of any kind, and the Declaration is clearly meant to apply equally to those who are furthest from attaining them. Only the last two articles, with their emphasis on duties and responsibilities, in any way limit those rights. "Everyone has duties to the community in which alone the free and full development of his personality is possible"; and the only limitations on the exercise of human rights and freedoms are declared to be such as are determined by law "solely for the purpose of securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society".

Safeguarding the State may obviously be made an excuse; but the exercise of State interference in accordance with elastic interpretations of democracy is limited by the final article: "Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein". Moreover, the inclusion of such reservations in a separate general article does not detract from the strength of the rest so much as would a succession of reservations to the individual articles. It is also worth noting that there has been a surprising degree of unanimity in adopting the successive provisions, and that this provision of a common standard of achievement is to lead to a later international covenant which will be even more binding.

Certain of the articles are vague, and the differing interpretations of such words as 'freedom', 'impartial', or 'protection' is bound to introduce some uncertainty, particularly in the economic field, at least until some such common tradition as lies at the basis of Western Union becomes of world-wide validity. Nevertheless, many of the articles can scarcely be misunderstood, and they supply strong support for the individual or the professional association in any demands for fulfilment they may have to make upon the State. There was, indeed, strong resistance from the Communist bloc to the inclusion of the right to freedom of movement and residence within the borders of each State, of the right of a person to leave his own or any other country and to return, to freedom of thought, conscience and religion, and the sharing of the common cultural life ; but the majority of the United Nations declared firmly for the provision of universality at the start of the Declaration and the sufficiency of the reservations at the end.

Clearly the Declaration embodies the principles which men of science have long held to be essential for the full vigour of a fruitful scientific and creative life, and the debates from which the Declaration has emerged can leave them in no doubt as to where the real dangers to scientific activity lie to-day. The Declaration obviously calls for close consideration from the Committee on Science and its Social Relations, and from the General Assembly of the International Council of Scientific Unions, in view of the resolution adopted by the latter Assembly in July 1946 and a subsequent declaration on the principles of a charter for scientific men since adopted by the Committee. It equally deserves consideration by that growing body of scientific workers concerned with ways in which science could help towards the maintenance of peace.

A comprehensive report on science and the maintenance of peace has been prepared for the Committee on Science and its Social Relations, but an interim report was issued by B. J. Bok, chairman of the U.S. National Research Council Committee of the United Nations Educational, Scientific and Cultural Organisation, for use at the Boston meeting of the United States National Commission on the latter body in September 1948. In that report, Mr. Bok attempted an analysis of the twenty-two replies received to two questions addressed during the summer to some forty representative scientific workers. Replies to the first question, dealing with the measure in which the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace, almost all stress the international character of science. Many clearly feel strongly that, because of the special nature of their work, they are in a favoured position with regard to international collaboration, though some believe that scientific contact alone has comparatively little to do with securing peace.

Much stress was laid in the replies to this question on the effectiveness of international exchanges of scientific workers at all levels, and on the value of international exchanges of scientific literature and advances in scientific abstracting. Moreover, the replies recognize the importance in this connexion of several projects undertaken by the Natural Sciences Department of the United Nations Educational, Scientific and Cultural Organisation, such as the establishment of the Field Science Co-operation Offices, the Hylean–Amazon Institute and the work on scientific reconstruction. One reply emphasized that the method of science assists men to put aside the conventional reactions and prejudices that hinder our understanding of unfamiliar things ; and that the evolutionary character of scientific theories helps to provide the flexibility of mind necessary for the maintenance of peace in a world so varied and diverse. The principle of freedom of inquiry, it is claimed, is a great asset in the maintenance of world peace because it is hard to reconcile with doctrinaire politics and dogmatic adherence to particular social or political theories. Whether or not this belief is too optimistic—and it was strongly attacked by implication by Dr. A. P. Lehner in his comments in the *Bulletin of the Atomic Scientists' Association* on a suggestion that scientific men and engineers should refuse to participate in weapons research and development—this view indicates sufficiently why the man of science cannot wisely neglect to support the Declaration of Human Rights, or to follow with interest the activities of the United Nations Educational, Scientific and Cultural Organisation.

The replies received to the second question, referring to the ways in which scientific organisations and individuals could intensify their activities for the maintenance of peace, yielded a number of suggestions with which the activities of Unesco are wholly in line, notably those in connexion with the forthcoming Scientific Conference on the Conservation and Utilization of Resources. Strong support was forthcoming for continuing the work of the international scientific unions and for increasing personal contacts among scientific men all over the world.

Nevertheless, the prevailing opinion seems to have been that it is a matter of hope rather than of history that the increasing knowledge of the world, improved communications and transport of goods and raised standards of living can minimize the causes of war by reducing stimuli to aggression. Prof. H. C. Urey sees the establishment of world government as our ultimate aim, but despite the general agreement that science fosters peace rather than war, Dr. K. T. Compton is supported in his view that the responsibilities for peace of scientific workers are just the same as those of any other group of citizens. He does not believe that it is feasible or, in the long run, safe for men of science to attempt to exert their own controls on the products of their work; and in this view Dr. H. N. Russell concurs, pointing out that the maintenance of peace is so entangled with sincere differences of social and political belief that it would be unwise for scientific organisations, as such, to endorse any particular programme. Dr. Lehner develops this point more particularly in his article in the *Bulletin of the Atomic Scientists' Association* already noted, and shows the difficulties to which the assumption by men of science of special responsibilities in this way would lead. There is no solution, he urges, in giving power to leaders of science, for they, too, are men ; and the economist comes firmly down on the same side, urging that the most those who want peace can do is to try to guide their fellow men by participation in political action for the world government that is necessary for peace.

At the meeting at Boston on September 28 when this interim report was discussed, Dr. A. H. Compton suggested that there are four ways in which it is appropriate for the United Nations Educational, Scientific and Cultural Organisation to use science towards the maintenance of peace. The first is by emphasis on human values; science and technology should be considered as means for attaining these values. The second is insistence on freedom and honesty in our search for knowledge. Next comes the development of science on a world-wide front, giving the opportunity for scientific men themselves to become the prototypes of the world citizen and thus to provide for all nations natural channels of human intercourse with their neighbours. Finally, there is the encouragement of the growth of science and technology throughout the world. Dr. Compton appears to regard this last as the most powerful existing force working towards world peace.

These suggestions were generally approved at that meeting, and a resolution adopted for forwarding to the United States National Commission urged that scientific men should work for the maintenance of peace in four ways: (*a*) They can emphasize and develop the human values associated with science and technology, and (*b*) insist on freedom in their search for knowledge. (*c*) Because of the natural one-worldness of their fields, they can consciously serve as prototypes of world citizens, and (*d*) by systematically promoting international co-operation, they can contribute directly to world integration and the construction of the defences of peace.

The subsequent report of the Committee of Science and its Social Relations issued in November 1948 gives an analysis of some seventy replies to the two questions, but its trend is sufficiently well shown by Bok's interim report, although some of the individual opinions quoted in the final report deserve attention. Generally, the replies to the first question testify to the existence of an international spirit among men of science, and regard its existence as favourable to the development of other aspects of international co-operation, in particular that of union, because men devoted to honesty, objectivity and freedom of scientific investigation, whatever their nationality, influence favourably other fields of human relations. Although one group of replies to the first question considers that men of science can exert a direct influence on the political world, either by appropriate public declarations or by the formulation of moral or ethical codes of conduct, the great majority see the most favourable possibilities of action in their normal activities. All correspondents, however, were unanimous in insisting on the necessity of intensifying their support of the projects for co-operation initiated by the United Nations Educational, Scientific and Cultural Organisation and by the international unions. Indeed, the whole inquiry brings out once more the independence of the scientific attitude, and the general belief among men of science that the fundamental contribution of science to world peace lies in the support it gives to freedom of thought, investigation and publication and the free circulation both of ideas and of men.

Little fresh has thus come out of the inquiry, and it may well be urged that the value of scientific work in creating an international spirit and encouraging the movement of thought across national frontiers needed no such demonstration. Nevertheless, some of the replies are valuable as indicating the dangers that lurk in proposals for direct political action by men of science as such. Perhaps more important is the demonstration of the existence of a substantial body of opinion which is following the activities of the United Nations Educational, Scientific and Cultural Organisation with interest and is capable of the cogent and constructive criticism of its activities which the Organisation needs. It is unfortunate, whatever the cause, that so little interest is taken in those activities in Great Britain. Parliament is obviously not interested, and there is no indication whether the universities, the professional organisations, the Churches and those practical people engaged in education, science and cultural activities generally are satisfied that the right projects are being attempted in the right way. A vigorous defence of the general purpose and policy of the Organisation was, it is true, offered by Mr. Ronald Gould at the recent conference on higher education held by the National Union of Teachers in London. Mr. Gould was careful to distinguish between criticism of administration, which might be merited, and destructive criticism of objectives.

However sound the fundamental conception of the United Nations Educational, Scientific and Cultural Organisation, that purpose of fostering co-operation and understanding among all peoples will only be achieved through the free flow of thought and expression throughout the world. The close support and keen interest of scientific workers is as essential a factor here as their support, interest and criticism are for the formulation of practical projects by which international co-operation and understanding can be furthered. The general indifference to the proceedings of the Organisation's recent meeting at Beirut is the more disappointing, for there was evidence that an attempt is being made to rectify past mistakes. Plain speaking is still required, and the most hopeful feature of the inquiry set on foot by the Committee on Science and its Social Relations is that it shows there are responsible men of science in the International Council of Scientific Unions who recognize the potentialities of Unesco, and whose standing ensures a hearing for any criticism they may have cause to make of its programme or administration. If such criticism is to be fully effective and this means of using science for furthering the maintenance of peace is to succeed, there must be public as well as scientific scrutiny; and one duty which scientific workers as citizens should undertake is to see that the projects of such an international body are rigorously scrutinized, the good approved and supported, and the weak exposed firmly but constructively as the obstacles they are in truth to the cause of international understanding.

THE COMPLETE CORRESPONDENCE OF LEEUWENHOEK

The Collected Letters of Antoni van Leeuwenhoek
Edited, illustrated and annotated by a Committee of Dutch Scientists. Vol. 3: 1679–1682. Pp. viii+565+48 plates. (Amsterdam: Swets and Zeitlinger, Ltd., 1948.) n.p.

THE third volume of this stupendous work includes letters 43–69 (old enumeration 28–36), and covers the period April 1679–July 1682. Seven of the letters, however, are those which have either not been recovered or have no scientific value, but which are properly catalogued in order to maintain the completeness of the record. It is of interest to note, but withal disappointing, that the new material now brought to light is of no great importance, and hence the letters already wholly or partly published in various quarters have so far not proved to be seriously deficient. Perhaps the most significant point to be established in the present volume is the date when Leeuwenhoek first discovered the nucleus of the animal cell. In the printed Dutch and Latin versions of letter 67 (35) it was doubtful whether he had seen the nucleus of the oval red corpuscles of fishes; but the original drawing now photographically reproduced for the first time shows clearly that he had seen the nucleus of the fish red corpuscle in March 1682. His next reference to the nucleus, this time in squamous epithelium, was in 1686. The etched figures in the Dutch and Latin "Opera" do not show the nucleus.

Among the diverse researches which Leeuwenhoek describes in these few letters are the following: spermatozoa of man and various animals, and how their number is estimated; the question whether spermatozoa and animalcula are complete miniature organisms with all the parts of larger complex forms; Hooke's demonstration to Charles II of some freshwater Infusoria (*not* spermatozoa); ciliary action of Infusoria and the gills of the oyster, and its uses; first mention of his observation of blood capillaries; viviparous generation in the female vinegar-eel; microscopic structure of the vessels of wood; histology of the testis of rat; discovery of anaerobic bacteria; impossibility of spontaneous generation; mechanism of the circulation of the blood; lacteal vessels of lamb and calf; biology of yeast; generation and anatomical notes on various insects and mites; microscopic structure and growth of hair in man and pig; discovery of the human intestinal flagellate *Giardia*; microscopic structure of striated muscle in vertebrates and invertebrates; nucleated red blood-corpuscles of fishes. On all these matters Leeuwenhoek produces new observations and acute inferences to the enlightenment of astonished readers.

In our previous reviews of this work (*Nature*, 144, 956, and 157, 3) we took occasion seriously to criticize its English translations. In the present volume the English version is very greatly improved and modernized. It is true that now and again the idiom is somewhat un-English, but without unduly affecting the interpretation. Thus a literal translation has not usually a 'literary' value, a gradually darkening border becomes a "slowly shadowing contour", an author "lays his views down" when he publishes them, the labial palps of the oyster appear as the "flaps" of the mouth, the ciliary action of the gills of the oyster "dabbles" the water, Leeuwenhoek's Royal Society diploma with appended seals appears ambiguously as a "sealed" diploma, and so on. These may not be considered serious defects; but they do underline the contention, which we have already twice maintained, that the English translation should be revised by an English biologist. Surely a great and essential work, such as this enterprise undoubtedly is, deserves, if it does not demand, the final polish.

The commentaries on the text supplied by a large group of specialists are especially valuable, but are occasionally unacceptable and more rarely inaccurate. The following points may be mentioned: p. 7, the statement that, according to the Dutch and Latin "Opera", there may be more than "10,000 thousand" animalcules in a space equal to one sand grain of matter does not occur in the Latin versions but only in the Dutch. P. 59, the blood capillaries were not first referred to in the letter of May 20, 1679, but in two letters of February 11, 1675, and May 14, 1677. P. 211, in *Mytilus*, Leeuwenhoek observed the *discrete* nature of the gill filaments and also the ciliary junctions; but he was not aware how they functioned in holding the filaments loosely together. The interpretation of the commentator would suggest that he was not too familiar with the structure of the gills of *Mytilus*. P. 229, line 6, for 1886 read 1686. P. 243, the first Latin edition of letter 62 has been accidentally omitted. P. 259, there are no gastroliths in the crab, which negatives the view that they constitute a reserve of calcareous material for use in the formation of a new shell. For such a purpose they are manifestly inadequate. They may be formed from the lime known to be abstracted from the shell before moulting to ensure that the process is unattended by amputations; but the same objection applies to this interpretation though to a less extent. The gastroliths figured in Plate 34 were obviously taken from the lobster. P. 323, the *big* horse-fly could scarcely be a *Hæmatopota*, and still less a *Stomoxys*. Why not a *Tabanus*? P. 331, the eggs of a gnat, notes Leeuwenhoek, had a *very clear* spot on one *side*. The commentator interprets this as the micropylar process, which does not tally with what Leeuwenhoek says. The clear spots might be the nuclei of the oocytes.

The Letters are followed by a reasoned critique by van Iterson, in which it is claimed that Leeuwenhoek's studies on the structure of wood (magnified seventy times) were largely independent of the contemporary works of Malpighi and Grew, and were in many respects superior to them. Leeuwenhoek is credited with being more restrained and intuitive in his deductions. Van Iterson is followed by Dijksterhuis, who reviews and collates the mathematical terms and micro-metric methods adopted by Leeuwenhoek, and in another place there is a list of the weights and measures employed in the Letters. The 48 plates of the volume introduce such extra figures as are necessary for the interpretation and illustration of Leeuwenhoek's observations and speculations, and, what is more important, we now have photographic reproductions of all Leeuwenhoek's own drawings, which may profitably be compared with the copper plates of the earlier printed editions. The book is completed by a bibliography and biographical notes on the authorities quoted in the text, and there is a good index.

The Leeuwenhoek Commission is to be handsomely complimented on its determination to continue the publication of this great historical work in the sumptuous style of the two volumes printed before the War. In Holland, apparently, questions of space, paper and binding have few terrors for the publisher. Last, but far from least, the large public unfamiliar with the Dutch language will be very grateful for the English translation.

F. J. Cole

THE GLOUCESTERSHIRE FLORA

Flora of Gloucestershire

Phanerogams, Vascular Cryptogams, Charophyta. Edited by the Rev. H. J. Riddelsdell, G. W. Hedley and W. R. Price. Pp. clxxxii+667+44 plates. (Cheltenham: Cotteswold Naturalists' Field Club, 1948.) n.p.

It is remarkable that so important a botanical area as the county of Gloucestershire should have had to await for so long the consummation of an account of its flora. The project was first conceived by the late Prof. Boulger some seventy years ago, and he had by 1878 compiled a list of more than a thousand species from this area. Nevertheless, except in respect of the Bristol region and casual records, very little real progress was again made until the impetus given by the Rev. W. Butt in 1905, and from 1908 to the time of his retirement by the Rev. H. J. Riddelsdell, who compiled what constitutes the main substance of the present work. But, though belated, the outcome is a Flora that is worthy of the botanical wealth which it enshrines.

There are here recorded 1,126 native species, 40 denizens and 23 colonists—a total of 1,189 species of vascular plants that includes such rarities as *Cephalanthera rubra*, the red helleborine, *Ranunculus ophioglossifolius* the adder's-tongue buttercup, and *Trinia glauca*, the honewort. Of all the species here enumerated, sixteen are noted as having become extinct, and of these, as is usual in other counties, the greatest proportion, namely, nine, are damp-habitat plants. Four of the extinct species are seaside plants and one is characteristic of woodlands.

The revision of names in accord with international rules has produced a number of unfamiliar labels for familiar friends, changes which cannot but be deplored when they do not reflect any increase of botanical knowledge. One new species is here described and figured under the name of *Epipactis cleistogama*.

The Flora is planned upon traditional lines, the records being grouped in respect to nine botanical districts. An unusual feature is the provision of keys to some of the groups, such as the Batrachian Ranunculi by Dr. Butcher, the Carices by Mr. Nelmes and the Gramineæ by Mr. Hubbard. The last-named has provided keys not only to the species in each of the genera but also to the genera themselves.

Gloucestershire has for the student of plant distribution an especial interest, since various species are here at or near their geographical limit. The pasque flower (*Anemone pulsatilla*) and *Senecio campestris*, both members of the Continental element in the flora of Britain, attain here their western limit, and this is true also of the Continental orchids, *Orchis ustulata* and *Himantoglossum hircinum*. But the ground pine (*Ajuga chamæpitys*) and the spider orchid (*Ophrys aranifera*) do not extend into the area. The endemic aconite (*Aconitum anglicum*), which is essentially a western plant in England, is here probably at its eastern limit, though, since it is stated that some of the records are probably garden escapes, the doubt arises whether the endemic plant has been adequately distinguished from its cultivated congener. The western *Andromeda polifolia*, on the other hand, has its eastern limit to the west of Gloucestershire. Again, the northern *Prunus padus* here attains its southern limit; but the local *Phyteuma tenerum*, though found in Wiltshire, fails to reach the chalk of Gloucestershire. These few examples suffice to indicate the importance of distribution data for this area and the need for biological studies in respect to such marginal species.

The present work is a notable addition to the county Floras of Britain and a valuable contribution to the literature of geographical distribution of plants in Britain. The text is embellished with views of typical Gloucestershire habitats and portraits of some of the rarer and more interesting species.

E. J. Salisbury

ELEMENTARY PHYSICS

A Laboratory Manual of Physics

For Higher Certificate, Scholarship and Intermediate Science Students. By Dr. F. Tyler. Pp. 207. (London: Edward Arnold and Co., 1947.) 7*s*. 6*d*.

Intermediate Physics

By Dr. C. J. Smith. Third edition. Pp. xii + 1033. (London: Edward Arnold and Co., 1947.) 18*s*. net.

Electricity

Text Book and Laboratory Manual for Inter.B.Sc., Higher School Certificate, University Scholarships, etc. By M. M. Das. Pp. xi + 483. (London: T. Murby and Co., Ltd., 1947.) 25*s*. net.

General Physics

By A. E. E. McKenzie. Pp. viii + 499. (Cambridge: At the University Press, 1948.) 8*s*. 6*d*. net.

Dr. F. Tyler's collection of experiments is intended to cover the practical work required for higher school certificate and university scholarships, and also for first-year university courses. Most of the really profitable class experiments which can be done with simple apparatus are included, and this carefully chosen list probably represents the highest common factor of all courses of this standard. Instructions, of the kind usually issued to students as 'manuscripts', explain the operations required, and show how the readings should be set out and the results calculated. The theory of each experiment is given in some detail, and, where the results are to be plotted, notes on the full interpretation of the graph are supplied.

Laboratory manuals can only reveal their quality in class, and it so happens that the reviewer has tried the book for more than a term with a small set of boys who had to work with little direct supervision. The results were satisfactory, and the pupils liked the book, which serves its purpose very well. Criticisms which arose in use are that the problem on the oscillation of a loaded tube on page 15 is more difficult than it appears, since the timing of more than a few oscillations is impossible; the directions for the location of neutral points in experiment 66 are those usually given, but are inadequate (it is suggested that Owen's method might be described in future editions, since this does find a point rather than a somewhat large area); and in the metre-bridge experiment it is surely better to calculate separate values for the resistance, and take the mean, than to average the balance-lengths first. The importance of recording each observation is stressed in the introduction, yet, in some cases, heights which are differences between observations are to be written in the notebook; and, since the accuracy of the observations is supposed to be estimated, some assistance in this might have been given by including a few lines of instruction below the actual observations.

Some small points perhaps deserve reconsideration. It is a half-truth to say that lycopodium sets in small heaps at the nodes in Kundt's tube experiment; the remarks on the cooling-curve experiment of p. 129 are inconsistent with the excellent discussion of Newton's law of cooling on p. 125; the chief purpose of the lid in the method of cooling is to prevent evaporation from the calorimeter; and if the width of the aperture in the Clément and Desormes experiment is considered, this is really a problem on critical damping—it is wrong to imply that oscillations occur with narrow rather than wide tubes when the reverse is the case. Perhaps it would be better also to discuss the damping correction for the ballistic galvanometer before the first experiment in which it is used, since this correction is often quite considerable, and should always be made.

The book is free from serious errors, and the instructions are unmistakably clear. It can be recommended as a valuable laboratory guide which both teachers and pupils should find most useful.

In its third edition, Dr. C. J. Smith's "Intermediate Physics" appears thoroughly revised and to some extent re-written. In the general physics section a short account of the method of dimensions has been added; in the heat chapters a full account is given of methods of determining thermal conductivity, and the chapter on radiation is chiefly new. The work on optical instruments has been considerably extended, and though the laterally expanded diagrams of ray traces at first look a little ungainly, their value is evident when one has become acclimatized to them; this kind of diagram is certainly something to commend to examination candidates. The section on wave-motion and sound is interesting, and does not sacrifice precision in order to economize the student's mathematics; this is, of course, work which is valueless unless it is done thoroughly, and there are no half-measures here. The account of Lissajous figures has been expanded; and the Doppler effect is very neatly done. In the electricity section, new material on dielectric theory and magnetometry has been included, and the chapter on electromagnetic induction revised.

The result is a very satisfying book, which not only includes all the material from which Intermediate examiners select their formal exercises, but also gives abundant guidance on those matters about which the better students themselves often ask such searching and shattering questions. Examples of this are the treatment of the Lees disk experiment for bad conductors, and of that frequent motion for debate, the simple magnifying glass.

Some experiments are described in detail—usually those which require some special care and are more difficult than students expect. Several good demonstration experiments which are old, but not often quoted, make a welcome re-appearance, and there are modern versions (which should work well) of some of the more temperamental of the stock repertoire.

The account of modern physics is necessarily brief. The author modestly says it is "just sufficient to whet the student's appetite for more, but not sufficient to distract him from the more fundamental parts of the subject". It might be said that Dr. Smith's admirable exposition of the fundamentals defies distraction; in any event, the last chapter contains all that one expects Intermediate or first M.B. candidates to know of this work.

The book is intended for scholarship candidates as well as Intermediate students, and what it really does is to cover the topics of the Intermediate syllabus at scholarship level; that is, although one would expect a scholarship boy to have read more widely, he would probably not need to go more deeply into the work that is presented here.

Few errors would be expected in a book which has reached its third edition after fifteen years of class use, and none was found; the words 'chemical' for 'thermal' on p. 204, and 'mainspring' for 'hairspring' on p. 751, are ingenious misprints rather than errors. The production and binding are good, and, for a book of this size and quality, the price is very reasonable.

Mr. M. M. Das's text-book, of Intermediate standard, on electricity deals with the mathematical theory of the magnetic and electric fields side by side in the opening chapters, and then discusses atomic structure before proceeding with the further development of the subject-matter. The treatment of magnetic measurements and magnetic materials is well done, in rather more detail than one usually expects at this stage, and the theoretical calculations throughout the book are clearly explained, particular attention being paid to the question of units. It is intended that the book should serve as a practical manual as well as a text-book, and while many of the experimental instructions are clear and adequate, they strike one as being, on the whole, too brief. There are a number of misleading slips: the theory of the quadrant electrometer is worked out plausibly by equating the *gain* of potential energy of the system to the work done on the fibre; "a new unit of potential, employed in nuclear physics, is the electron-volt"; atomic weight and mass-number are identified; and it is stated that the penetrating power of X-rays is inversely proportional to the wave-length. The price of the book seems unduly high, and would, one imagines, prevent any wide adoption as a class-book. For twenty-five shillings, too, we might have been given the answers to the numerical examples. But the author has thought out his own method of presentation, and teachers in search of ideas will scan the book with interest.

Mr. A. E. E. McKenzie has selected the appropriate material from his well-known series of text-books so as to include in a single volume all the work needed for the rather limited physics syllabus of the school certificate general science paper. The book covers this ground lucidly and well. It embodies all the pleasing features of the earlier ones, and has some new and relevant illustrations, selected with an artist's eye. There was an obvious need for such a book, and Mr. McKenzie has filled it satisfactorily.

G. R. NOAKES

Inductance Calculations

Working Formulas and Tables. By Prof. Frederick W. Grover. Second printing. Pp. xiv+286. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 31*s*. 6*d*. net.

PROF. F. W. GROVER makes an authoritative selection among the numerous formulæ which have been suggested for the calculation of mutual and self inductances. He does not attempt proofs of the formulæ, but gives adequate references to the original papers. He gives sufficient explanation of general principles to allow the adaptation of the formulæ to particular cases which are not directly covered (an improbable contingency, however). As the majority of exact formulæ are cumbersome to use, he usually offers numerical tables giving an accuracy of 1 in 1,000 or better, with some indication of the accuracy. Where interpolation between tabulated values would be inaccurate, he gives either alternative formulæ or tables using a different argument. Every likely shape and relative disposition of circuit element is included. There are formulæ for deeply wound coils, and for coils of spaced turns of round wire or of flat tape. The discussion of inductance at high frequencies is less precise than the rest of the book—excusably so, in view of the uncertain effects of self-capacitance. (Here is a field for some useful new work.) The mechanical forces between inductors are also calculated.

The most serious criticism is that the detailed contents pages do not atone for the lack of an index. The "Appendix" promised on p. 26 proves, on diligent search, to be Chapter 22 (which is not the last in the book). Most of the tables are admirably set out; but the type is sometimes small, for example, on p. 84, where it is difficult to count the zeros preceding the significant figures. There is a real need for a work of reference of this kind, and the increased scope of this book, as compared with its predecessors, makes it very useful indeed. A. C. LYNCH

Organic Evolution

By Prof. Richard Swann Lull. Revised edition. Pp. xx+744+31 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 40*s*. net.

ALTHOUGH bravely marked as "Revised Edition" on the title-page, this appears to be no more than a reprint of the revised edition of 1929, which was itself not greatly modernized from the original of 1917. Perhaps it would have been kinder to have allowed this old favourite to go out to grass on the upper shelves of the library. The sections on adaptation to different environments, and the chapters on the evolutionary comparative anatomy of various groups of animals still provide an easily read, if out-of-date, introduction for elementary students. But the sections dealing with the processes of evolution are pathetic. The single short chapter on "Heredity", for example, contains fairly long paragraphs on such pre-genetical ideas as atavism, telegony, prenatal influence and the transmission of parental conditions; and although a sentence is inserted stating that "What is called telegony does not actually exist", the discussion leaves the definite impression that all four ideas are more or less acceptable biological concepts. The following paragraph on sex determination achieves the noteworthy feat of discussing this problem without once mentioning chromosomes; but the discussion on Mendelism, after devoting a total of four pages to an explanation of the F_2 1 : 2 : 1 ratio, does reach out towards the present sufficiently to incorporate a final two lines: "Mendel's laws, therefore, are apparently a generalisation of the greatest importance and apply universally to all cases of inheritance". C. H. W.

Copsford

By Walter J. C. Murray. Pp. 164+23 plates. (London: George Allen and Unwin, Ltd., 1948.) 12*s*. 6*d*. net.

IN many branches of physical science the amateur is inevitably becoming less important; in the observational branches of natural science his place is still as secure as it was in the days of Gilbert White, Jefferies or Hudson; and occasionally someone appears who shows the contribution which the non-professional can still make not only to our knowledge of natural life but also to its significance for the well-being of man.

Such a one is Walter J. C. Murray, whose "Copsford" gives us perhaps one of the most intimate accounts of Nature since Hudson wrote his "Far Away and Long Ago" some thirty years ago. Murray spent a year in a lonely cottage with neither road nor footpath connecting it with human habitation, working among the wild life which surrounded him. There he struggled with the elements, earned a living by harvesting wild herbs and waged continual war against the legion of rats which contested his right to live in Copsford.

He has now written a book about the countryside which is full of the most intimate experiences among the wild life of woodland and meadow, marsh and brook. In his book the author conveys the impression that he not only lived among wild things but also with them, light and darkness, sound, scent and movement becoming as vital in his life as in theirs. This strange, amusing and exciting story is told in prose which in itself is a pleasure to read. "Copsford" deserves the widest possible acquaintance.

T. H. HAWKINS

The Phasian Bird

By Henry Williamson. Pp. 341. (London: Faber and Faber, Ltd., 1948.) 10*s*. 6*d*. net.

IN this latest volume from his pen Mr. Henry Williamson tells of life on a Norfolk farm during the Second World War, taking as his hero a bird, namely, a hybrid pheasant. With the pheasant as principal character—it was seemingly a cross between the common pheasant and Reeves' pheasant—and such subsidiary characters as "Pertris" and "Pertrisel", the partridges, we see not only the wild life of this corner of eastern England but also the farm life, both human and animal. It is a tragic picture that Mr. Williamson paints, a picture of endless effort to cultivate the stern land, of despair and bitter frustration, of endurance and grim determination that win through, all depicted in the author's well-known vivid style.

F. P.

Interaction of Water and Porous Materials

(Discussions of the Faraday Society, No. 3, 1948.) Pp. ii+294. (London and Edinburgh: Gurney and Jackson, 1948.) 30*s*. net.

THE discussion on this subject held by the Faraday Society during March 31–April 2, 1948, was reported in an article in *Nature* (161, 629; 1948). The full text of the papers has now been published, with accounts of the discussion at the meeting.

STELLAR EVOLUTION AND THE EXPANDING UNIVERSE*

By F. HOYLE
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THEORIES of the expanding universe have all been constructed in accordance with the following data:

(*A*) The distribution of nebulæ over the sky is approximately uniform, the approximation becoming better as fainter nebulæ are used in the compilation of the statistics.

(*B*) A relation, discovered by Hubble and Humason, exists between the red shift ($\delta\lambda/\lambda$), usually denoted by δ, of the whole spectrum of a nebula, and its apparent magnitude m. This relation, which can be written in the form

$$\log_{10} \delta = 0{\cdot}2\, m - X, \qquad (a)$$

where X is an observed constant, has been verified for apparent magnitudes less than 18, and is independent of the directions of the nebulæ relative to the earth.

It has been generally accepted that (*A*) can be taken as demonstrating the large-scale homogeneity and isotropy of the spatial distribution of matter, and all theories work in an approximation in which the material in the nebulæ is regarded as being smeared out into a uniform background. In terms of Einstein's theory of general relativity, Weyl interpreted (*B*) as showing that, in the same approximation, the world lines of different elements of material form a bundle of geodesics without envelope that spread outwards from a point. This postulate much simplifies the solution of Einstein's field equations, which, in a common notation, take the form

$$G_{\mu\nu} - \tfrac{1}{2} g_{\mu\nu} G + \lambda g_{\mu\nu} = - \varkappa T_{\mu\nu}, \qquad (b)$$

where λ is a cosmical constant. For, by choosing geodesic co-ordinates, a universal time can be defined that leads to a comparatively simple expression for the line element. A detailed review of the models derived on this basis has been given by Robertson[1].

(*A*) and (*B*) do not exhaust the available data concerning the expanding universe. Thus, Hubble and Tolman have attempted to use:

(*C*) the observed distribution of nebulæ as a function of apparent magnitude,

as a criterion for deciding between the various models satisfying (*A*) and (*B*). It is now generally agreed, however, that a substantial reduction in the errors of measurement is necessary before this criterion can be decisive. The required improvements will eventually be forthcoming from the 200-inch telescope at Mount Palomar. In the meantime, other criteria can be developed from the results of astrophysical research. Among the more important of these results the following may be briefly mentioned:

(*D*) The brightest stars observed in the central regions of nearby spiral nebulæ, in globular clusters and elliptical nebulæ are of closely comparable luminosities. A consideration of the origin and development of these stars yields ages of about 5×10^9 years for the nearby nebulæ. The method used in this determination appears devoid of substantial error; it seems fairly certain that the ages could not be less than 3×10^9 years or greater than 7×10^9 years.

(*E*) In spite of the steady conversion of hydrogen to helium and higher elements, taking place within the stars, which amounts to the transformation in 10^9 years of about 0·1 per cent of the hydrogen present in the nebulæ, hydrogen still constitutes about 99 per cent of all material.

(*F*) The rapidly increasing evidence in favour of the widespread existence of internebular material makes it difficult to resist the conclusion that the nebulæ represent condensations in an internebular medium. The density in such a medium could not be greater than the lowest densities, of about 10^{-25} gm. per cm.^{3}, observed in the nebulæ themselves. On the other hand, the density could not be much less than 10^{-27} gm. per cm.^{3}, otherwise the period required for nebular condensation would become unacceptably large.

(*G*) There is a marked clustering tendency among the nebulæ. Clusters vary greatly in size from pairs of nebulæ up to those containing more than a thousand densely packed members. This indicates that the internebular medium is unstable against the formation of localized condensations; that is, a condensation, following essentially Newtonian dynamics in its internal structure, must be formed wherever the density in a particular region exceeds the mean density in the general background.

We now mention briefly the reasons why models, satisfying (*A*) and (*B*) and equations (*b*), are nevertheless unsatisfactory. The following cases may be distinguished. (i) *Oscillatory universes.* (*F*) and (*G*) can be satisfied, but *E* is an overriding difficulty. These models contain material of finite density but of infinite age. Thus the irreversible conversion of hydrogen into helium and higher elements would have exhausted the hydrogen content of the universe, in contradiction with the observed predominance of hydrogen. (ii) *Universes with zero cosmical constant (excluding oscillatory cases).* These models have a point source origin and are of finite age. But the ages given when (*B*) is satisfied are not appreciably greater than 10^9 years. Accordingly there is a direct contradiction with *D*.

(iii) *Universes with non-zero cosmical constant (excluding oscillatory cases).* It is convenient to treat these models in the following order: (*a*) *The Lemaître–Eddington universe.* By choosing an appropriate relation between the cosmical constant and the density of matter in the uniform background, Einstein found that a static finite universe could be obtained. It was shown by Eddington[2] that this universe is unstable against a perturbation of volume; an increase in volume leading to an unlimited expansion that had been discussed previously by Lemaître[3].

This model is in contradiction with (*D*) and (*G*). For condensations can form only during the pre-expansion stage, on account of the disruptive effect of the cosmical constant. But an infinitesimal perturbation of the Einstein state requires such condensations to have infinite ages. Even for a finite perturbation, such as that considered by Eddington[4], the ages are of order 5×10^{10} years. The origin of a finite perturbation sufficiently large to give ages appreciably less than 5×10^{10} years raises what appears to be a fatal difficulty.

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* Substance of a series of lectures given at the Royal Institution on October 26, November 2 and 9.

(*b*) *The Lemaître universe.* There is an infinity of point source models possessing unlimited expansion. The nebulæ are not appreciably older than 10^9 years in the models of shortest age. On the other hand, there is a model of infinite age that passes through the Einstein state with infinitesimal velocity. Between these two extremes it is possible to obtain a model with an age of 5×10^9 years. Thus (D) can be satisfied for a suitable choice of the initial conditions.

This model fails, however, as all point source models do, on account of (F). For, in the early stages of expansion, the material in the general background is unstable against the formation of condensations. Thus condensations would be formed in material with density much higher than the mean densities within the nebulæ. No such condensations are observed. Detailed considerations show that this crucial objection cannot be overcome through the action of gas or radiation pressure. (The work of Adams[5], as interpreted by McKellar[6], requires the present background temperature to be not greater than about 1° K., from which it can easily be shown that the thermal energy density is everywhere very small compared with the energy density of matter. Although, according to the theory, the ratio of thermal energy to the rest energy of matter was greater in the past, such an increase in the importance of thermal energy is far from being sufficient to invalidate the present argument.) It may also be noted that, due to the effect of the cosmical constant, G also presents a serious difficulty.

Before considering new possibilities, the suggestion may be dismissed that the universe might be static, the observed red shifts of the spectra of the nebulæ being supposed to arise from some unknown cause. This notion fails for the same reason that oscillatory universes are unsatisfactory. Thus, since a static universe is of necessity of infinite age, no hydrogen could be present on account of the irreversible conversion into helium and higher elements. Nor can the difficulty of obtaining a satisfactory system of cosmology be ascribed to Einstein's formulation of relativity. A similar situation appears to arise in Milne's kinematical relativity, which leads to a universe having considerable similarity with the case, mentioned above, of zero cosmical constant. Indeed, the remarkable demonstration by Milne and McCrea[7], that Newtonian analogues exist for all the models discussed above, clearly shows that the solution of the cosmological problem must be sought in an essentially new concept.

Accepting the red shifts of the nebular spectra as indicating expansion, the outstanding question may be stated in the form: Why do condensations not exist with mean densities much greater than the observed mean densities in the nebulæ ?

At first sight, expansion seems to require that the density of matter in the general background must in the past have been much greater than the observed mean densities in the nebulæ. This leads to the impasse that dense condensations would certainly have been formed. The difficulty can be avoided by supposing that expansion does not require the background density to have been greater in the past. For this condition to be satisfied matter must be created continuously. The idea of continuous creation is not new. Jeans[8], and more recently Milne[9], have discussed the possibility of explaining the origin of the spiral arms observed in many nebulæ in terms of the creation of matter at their centres. Dirac[10] has emphasized the cosmological importance of continuous creation, and this question has been considered by Bondi and Gold[11] and also by the writer[12].

The homogeneity requirement (A) suggests that creation takes place uniformly in the general background, rather than at the centres of the nebulæ, as suggested by Jeans. Weyl's postulate, mentioned above, provides a convenient means of formulating continuous creation in mathematical terms. The main effect is to introduce a new tensor in the left-hand side of (*b*). Putting λ equal to zero, it can then be shown that there is but one steady-state solution of the field equations. Moreover, whatever the initial conditions, this state is reached in a comparatively short length of time.

The condition (G) is satisfied. That is, the material in the background is always unstable against the formation of condensations, although when averaged on a very large scale the density is uniform not only in space but also with respect to the time co-ordinate. The line element is identical with the well-known de Sitter form. This requires a relation (*a*) to be strictly satisfied. The theoretical value of X can be arranged to agree with the observed value by an appropriate choice of the creation-rate, which is the only free parameter in the theory. This leads to a background density of about 5×10^{-28} gm. per cm.^{3}, and a creation-rate of about 10^{-43} gm. per cm.^{3} per sec. The latter value is far too low to be observable in the laboratory.

Bondi and Gold[11] have shown that (C) is also satisfactorily explained in the present model. This agreement with observation is particularly noteworthy, for, once the creation-rate has been fixed so as to give agreement with the observed red shifts, no adjustable parameter remains in the theory (in contrast with many other models), which therefore stands or falls according as to whether (C) is accounted for or not.

Although the present universe is of infinite age, individual nebulæ possess finite ages. Investigation shows that nebulæ observed to be receding from the earth must have theoretical ages lying between 2×10^9 years and about 10^{10} years. The individual field nebulæ are associated with the lower age limit, and the great nebular clusters with the upper age limit; that is, the number of nebulæ contained in a cluster is a measure of its age. According to (D), nearby nebulæ have an age of about 5×10^9 years. This indicates a moderate degree of clustering in the neighbourhood of our galaxy. It is satisfactory that this requirement is in agreement with observation, which shows that our galaxy is a member of a local group of nebulæ.

(E) is satisfied provided the created material consists either of hydrogen or of neutrons. (F) is automatically satisfied for a background density of 5×10^{-28} gm. per c.c.

It is not the purpose of this article to enter into the philosophical implications of the continuous creation of matter. Nevertheless, the following two points may be mentioned. (*a*) The resulting universe possesses both an infinite past and an infinite future throughout which the large-scale properties must remain unchanged. Thermodynamics has only localized significance. There is no large-scale 'running down' towards a general heat death. (*b*) Eddington attached much significance to a coincidence between the observed value of X and a number that can be built up out of the constants of microscopic physics. This coincidence, which is probably of great importance, appears in the present theory as a relation between the creation-rate and the microscopic constants. The existence of this relation is a warning that the theory in its present form is probably far from being complete. At the same time it provides a hope that a deeper understanding of the creation process may ultimately be forthcoming.

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INFRA-RED SPECTROSCOPY WITH THE REFLECTING MICROSCOPE IN PHYSICS, CHEMISTRY AND BIOLOGY

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A. R. H. COLE*

AND

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DURING recent years infra-red absorption spectroscopy has been applied in a variety of physical and chemical problems. For example, the individualistic character of a molecular vibrational absorption spectrum has been used in the chemical analysis of mixtures of complex organic substances[1], and the constancy of the vibration frequencies of particular atomic groupings assists diagnostic work on polymers and other compounds of high molecular weight, or on substances of chemotherapeutic interest[2]. Another application is the study of the structure of the solid state, and the use of polarized infra-red radiation here promises to give important information[3].

Although it has been possible by means of the so-called 'powder' technique to obtain spectra with only a few milligrams of material, there are many cases—particularly with new antibiotics or other extracts—where even this small quantity is not available, at least in the early stages of an investigation. The matter may also be complicated by having to use liquid paraffin as a base for the powder, since its absorption bands often overlie spectral regions of interest. The desirability of being able to use extremely small amounts of material becomes greater in biological problems such as the measurement of spectra of individual cells, of fibres, or of tissue sections. For all these reasons some form of microscope has long been desirable. Also the applications with polarized infra-red radiation would be much simplified if it were possible to use a small crystal of material or oriented fibre, rather than having a fairly large artificially prepared layer or film.

The microscope has already been used in spectroscopy, both in the visible and ultra-violet[4]. In the latter case, Caspersson[5] and others have used a quartz refracting instrument with success. This method has shortcomings, however, since the instrument must be refocused as the wave-length is changed, and absorption by the system of lenses restricts the spectral range available. The development by Dr. C. R. Burch of a reflecting microscope[6] therefore leads to an important extension of the whole method, since the achromatic nature of the instrument and the entire absence of absorbing materials make it serviceable from the extreme ultra-violet to the far infra-red. Using a continuous source of radiation, such as the hydrogen discharge tube, it has been possible[7] to measure the ultra-violet and visible spectrum of cystals and blood cells. The investigation of spectral changes as different parts of a cell are measured is of great interest.

On the other hand, the use of ultra-violet absorption spectra has certain limitations. Difficulties may arise, for example, because of photolysis; but more important, the band systems of complex molecules are too often composed of broad absorption maxima which are not very specific in revealing the nuclear skeleton of the molecules involved. In this respect, the greater specificity of vibrational spectra in the infra-red has often been emphasized.

We have therefore been fortunate in being able to use the Burch microscope with a Perkin Elmer recording infra-red spectrometer, and have now obtained spectra between 2 and 15 μ of particles, without recourse to slit-widths so large as to reduce the spectral resolution too badly. Prisms of rock salt and lithium fluoride have so far been used, but there seems no reason why the range should not be extended to longer wave-lengths with a prism of potassium bromide. Radiation from a Nernst glower passes through the microscope and sample, emerging to give a magnified image (100–1,000-fold), which can be seen by the eye. The sample is placed on a thin plate of rock salt, quartz or other transparent material. By means of a small preliminary slit of variable aperture, different parts of the object can be selected, and the radiation through these parts directed by means of focusing mirrors on to the entrance slit of the spectrometer. The weight of substance used in the present work is in general 10^{-7}–10^{-8} gm. The minimum size of particle which can be used depends on the resolving power of the microscope, which in turn varies with the wave-length. We have, however, obtained good records with crystals and fibres 20–50 μ in diameter. We have also been able to investigate polarization effects using a selenium mirror following the microscope, the sample under examination being rotated in a horizontal plane.

Some examples of the results so far obtained are described briefly in the following.

(1) It was required to measure the spectrum of a minute crystal of 'bialin', which had been extracted

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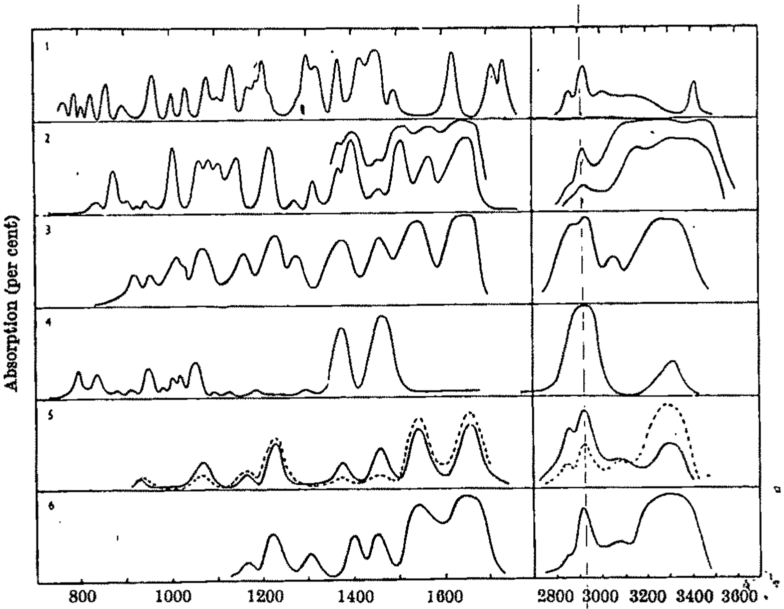


Fig. 1

1. Bialin.
2. Antipernicious anæmia extract (vitamin B12).
3. Gramicidin B.
4. Cholesterol crystal.
5. Full curve, frog nerve fibre; dotted curve, frog nerve after extraction with chloroform.
6. Frog muscle fibre.

from the mould *Penicillium Bialowiezense*, and in particular to establish its identity, or otherwise, with a similar small crystal of mycophenolic acid obtained from *Penicillium brevi-compactum* (Dierckx). The spectra proved to be identical over the region 2–14 μ; further, using higher dispersion in the region of 3 μ, the behaviour of the two samples in polarized radiation was exactly similar (Fig. 2, *C*). Any other method of establishing this identity with such small quantities of material would perhaps have been impossible, and chemical methods would certainly have required much more material. Another important point is that the use of paraffin as a base for the powder is avoided, and the important regions of the C—H absorption bands are not obscured.

(2) A small crystal of the anti-pernicious anæmia factor (vitamin B12) isolated by E. Lester Smith[8] was examined with a view to structural diagnosis. From the spectrum shown in Fig. 1 (2), it is seen that the stretching vibrations of CH_2 and CH_3 groups lying near 2,900 cm.$^{-1}$ are comparatively weak, and this is indeed paralleled by the weak nature of the corresponding C—H deformational modes near 1,460 cm.$^{-1}$ and 1,375 cm.$^{-1}$. By contrast, there is a broad region of strong absorption between 3,200 and 3,500 cm.$^{-1}$ which must be due to bonded O—H or N—H groups. This region also appears to have sub-maxima, and one of these may indicate the stretching mode of C—H bonds in an aromatic or heterocyclic nucleus such as the pyrrol or pyrimidine type. The character of the region of O—H absorption is more like that usually found for bonded hydroxyl groups of an alcohol or phenol than that of hydroxyl groups in a carboxylic acid, but further comparison with model substances would be profitable.

Taken as a whole, the spectrum does not show the general features found with a polyamide[9], with which strong bands occur near 1,470, 1,550, 1,640, 2,950 and 3,300 cm.$^{-1}$. The strong band near 1,660 cm.$^{-1}$ may indicate C=C or C=N links rather than peptide C=O groups, which again may occur in a cyclic compound of the kind just mentioned. Correlation of other bands in the spectrum with constituent groups is at present difficult, but it may be noted that, on the basis of other measurements in progress here[10] on the alkyl phosphites, phosphates and phosphonates, there is indication of phosphorus–oxygen links in vitamin B12. If the substance proves after all to be substantially a polyamide in nature, its spectrum must be considerably masked by other parts of the molecular structure.

(3) The spectrum of gramicidin B (Fig. 1, 3) shows the group of five strong bands usually found with polyamides between 1,400 and 3,400 cm.$^{-1}$ as well as the weak band near 3,060 cm.$^{-1}$. In this case the bands at frequencies less than 1,400 cm.$^{-1}$ were broader than usual; but further comparisons with model compounds might lead to correlations with particular amino-acid residues concerned. Samples of insulin gave similar results.

(4) Small quantities of other substances typical of those encountered in biochemistry have been measured, such as cholesterol, tryptophane and methionine. The spectrum of cholesterol (Fig. 1, 4)

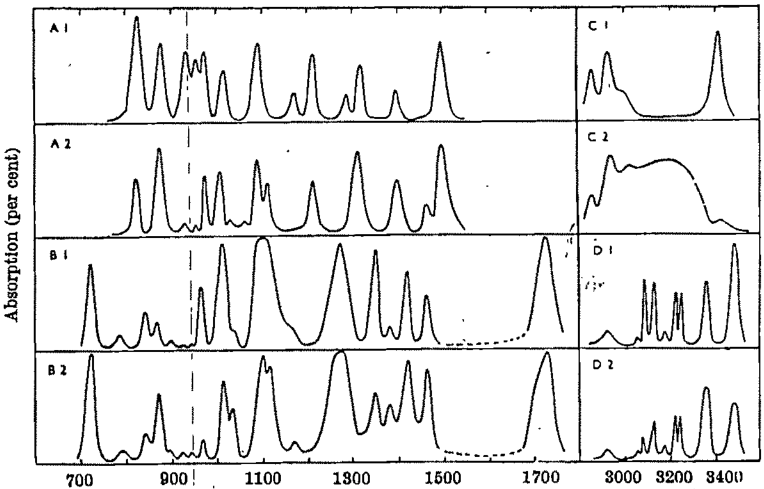


Fig. 2. Polarized radiation

A 1, 2. *p*-Chlorobenzaldoxime crystal, 0° and 90°.
B 1, 2. Terylene fibre, 0° and 90°.
C 1, 2. Mycophenolic acid, 90° and 0°.
D 1, 2. *p*-Nitraniline, 90° and 0°.

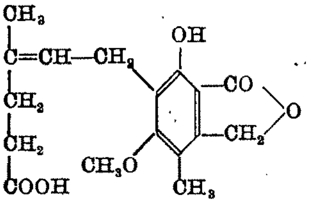
is noteworthy for its relative simplicity, the marked bands due to C—H vibrations and the weak O—H band near 3,420 cm.$^{-1}$. We would again emphasize here the advantages of obtaining the spectra in absence of 'Nujol'.

(5) We have also measured the spectra of fibres, including hair, casein, terylene, muscle and nerve fibres. The spectrum of frog nerve (Fig. 1, 5) shows the main features of a polyamide; but after a rough extraction with chloroform there are marked alterations in the relative intensities of certain bands. This extraction diminishes the strength of the stretching and bending vibration bands of C—H bonds near 2,900, 1,460 and 1,375 cm.$^{-1}$ and causes the bonded O—H group to appear more intense. This is what would be expected for the removal of lipides. The reduction in intensity of the band near 1,080 cm.$^{-1}$ is also consistent with the removal of —C—O— bonds such as occur in esters[11], and in this connexion it is interesting that the strong band near 1,235 cm.$^{-1}$ appears to be in the polyamide rather than the lipide.

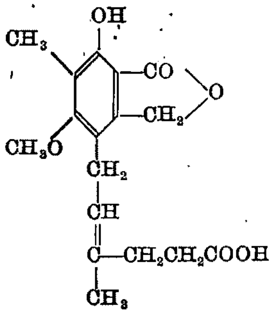
The spectrum of frog muscle (Fig. 1, 6) also shows the main features of a polyamide, but at frequencies less than 1,500 cm.$^{-1}$ there are definite differences from the spectrum of nerve, and the relative intensities of the C—H and bonded O—H vibration bands are different in the two cases. It is clear that a more detailed study of this whole problem might be very informative.

(6) The use of polarized infra-red radiation for studying the internal structure of crystals, ordered crystalline aggregates and oriented polymers was previously investigated by Mann and Thompson[12], and later extended by Ambrose, Elliott and Temple[13] and by Jones and Sutherland[14]. Its value in the present work is greater because small single crystals can be used without the need of obtaining large uniformly oriented films, fibres can be studied at successive stages of 'drawing' or orientation, and very small areas of polymer films can be used. Alternatively, in the latter case small areas in a large film of polymers can be studied to compare the degree of order in the structure.

A number of substances were measured for comparison with the earlier work on a macroscopic scale, such as acetanilide and adipic acid, and full agreement was found. Fig. 2 (*D*, 1, 2) shows the spectra of small crystals of *p*-nitraniline near 3 μ, and (*A*, 1, 2) of *p*-chlorobenzaldoxime between 7 and 14 μ, with the incident electric vector respectively parallel and perpendicular to the crystal axis. This figure also shows the corresponding results for terylene between 7 and 14 μ (*B*, 1, 2) and mycophenolic acid near 3 μ (*C*, 1, 2). The change in spectrum with mycophenolic acid between 2,800 and 3,600 cm.$^{-1}$ is interesting since it reveals the simultaneous existence of two types of O—H bond, one feebly and the other strongly 'bonded'; and the bonded type behaves like a carboxylic hydroxyl group. This result is consistent with the structure which has been assigned to the substance in the sense that it has been thought to contain both a carboxyl group and a phenolic hydroxyl group. There has been doubt, however, about the relative positions of the substituents around the aromatic nucleus, the formula being either (*a*) or (*b*)[15]; and it seems on the basis of the present results to suggest (*a*) rather than (*b*), since in the case of (*a*) the steric effects might be more likely to prevent association of the phenolic hydroxyl group.



(*a*)



(*b*)

In the case of terylene, the polyester from terephthalic acid and ethylene glycol, marked changes of intensity are found between 7 and 14 μ, although the band near 1,720 cm.$^{-1}$ due to the carbonyl groups is little affected by directional change. The details of this case will be discussed in relation to the crystal structure elsewhere[16], but we would emphasize here the spectral difference detected with fibres which have been 'drawn' to different extents; and even using unpolarized radiation, some spectral changes have been found between stretched and unstretched samples which can be interpreted in terms of special orientation of certain bonds.

The application to individual small crystals such as those of *p*-chlorobenzaldoxime opens up the possibility of cutting crystals along several principal directions, and thence, from computation of intensity of key bands, the deduction of the crystal structure projections on several planes.

In connexion with the carcinogenic activity of certain derivatives of *p*-dimethyl aminostilbene, it has been suggested that coplanarity or otherwise of the two aromatic nuclei may be related to the electronic structure requisite for activity[17]. Since characteristic bands are now known for the several kinds of substituted aromatic nucleus, the use of polarized radiation in crystals of these compounds might throw light on this problem[18], and measurements of this kind are now being made.

(7) Another line of work which can now be explored is the infra-red spectral absorption of biological cells. We have made preliminary measurements with several samples such as blood, and obtained good spectra. If the intensity of the source of radiation and the numerical aperture of the microscope can be increased, as seems possible in several ways, it should become feasible to examine different parts of the single cell and, in some measure at least, to investigate variations in chemical composition. The possibility of following cellular processes continuously, using the cathode ray tube infra-red recorder, may then be realized.

These examples serve to illustrate the manifold applications which may now be made using the new microscope. There are numerous possible improvements, such as the construction of a microscope of greater aperture, and the provision of a more intense beam of radiation. It seems, however, established that the method will not only form an important step forward in crystal analysis, but also a valuable weapon in much biological work.

We wish to express our appreciation to the Nuffield Foundation for a grant in aid of equipment to be used with the microscope, and also to the American Cyanamid Company for the generous gift of the

infra-red spectrometer used. We are also grateful to all those who have provided materials for study.

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OBITUARIES

Dr. Marjory Stephenson, M.B.E., F.R.S.

MARJORY STEPHENSON was born at Burwell in Cambridgeshire on January 24, 1885; she died in Cambridge on December 12, 1948. She was educated at Berkhamsted School for Girls, and at Newnham College, where she was later to be associate and fellow. As circumstances prevented her following her wish for a medical degree, she equipped herself at the Gloucestershire Training College of Domestic Science, and taught for a time there and at King's College of Household Science, London. Soon she had an opportunity to begin biochemical research work at University College, London, under Dr. R. H. A. Plimmer; her first paper, on animal lactase, was published in 1912. The next year she was aided by a grant from Newnham College, and a little later was awarded a Beit Memorial Research Fellowship; but her newly begun career was interrupted by the First World War. She served with the British Red Cross during 1914–18, first in France and then in Salonika, where she was V.A.D. commandant. Her work was recognized by the award of the M.B.E. and the Royal Red Cross.

In 1919 she returned to research, this time at the Biochemical Laboratory, Cambridge, with Sir Frederick Gowland Hopkins. At first she took part in the vitamin work already in full swing in the Laboratory, becoming interested in the fat-soluble vitamins. This interest led on to her work, with M. D. Whetham (later Mrs. A. B. Anderson), on the fat metabolism of the timothy grass bacillus, and thence to more general studies of these and of fermenting organisms. She had now found her life-work and remained in Cambridge, in the favourable milieu of Hopkins' department, developing the science of chemical microbiology, and teaching and inspiring a long succession of pupils and collaborators. Her influence became world-wide; she opened up several new fields of study, some of which have since been brilliantly developed by her pupils.

As time went on, Dr. Stephenson became more and more impressed by the importance of chemical microbiology as a special discipline, not only valuable to the community on account of its industrial and medical aspects, but also capable of making a unique contribution to the progress of scientific thought. This theme she developed in her lecture before the congress which celebrated the centenary of Pasteur in Paris in November 1946. For many years she was on the staff of the Medical Research Council, and in 1944 her tireless efforts led to the formation of the Council's Unit for Chemical Microbiology. In 1948 she was appointed to a University readership at Cambridge. She also played a great part in the founding of the Society for General Microbiology and was its president at the time of her death; many will long remember the charm and lively enthusiasm with which she presided over its conference last September. Three years earlier, she and Dr. Kathleen Lonsdale had been the first women to be elected into the ordinary fellowship of the Royal Society.

Her book "Bacterial Metabolism", which so greatly enhanced her international reputation, appeared first in 1930. The third edition, entirely re-written, is now on the point of publication. It is animated throughout by the imaginative insight which enabled her to consider the microbe, not as a useful device or as a pest to be eliminated, but as a living organism going about its own legitimate business.

In her early work, for example, with J. H. Quastel and L. H. Stickland, she dealt with several subjects of which time has only emphasized the importance—for example, the role of —SH groups in metabolism, or the possibility of energy provision under anaerobic conditions by the interaction of specific hydrogen donators and acceptors. She was the first to demonstrate, in cell-free extract, the presence of a specific (lactic) dehydrogenase from bacteria, and her work on hydrogenase and hydrogenlyase (with L. H. Stickland, D. D. Woods and J. Yudkin) has become classical. The observations on these enzymes aroused her interest in the subject of adaptive enzymes, to which she and her school (now including E. F. Gale) made outstanding contributions.

In 1937 she became interested in the importance of nucleic acid derivatives in cell metabolism, and with characteristic thoroughness embarked on a study (with A. R. Trim) of the changes which the adenine compounds themselves undergo in the presence of bacterial enzymes, as a preliminary to studying their mode of action in the cell. Several years later she came back to the theme of nucleic acid metabolism, and her last paper (with J. Moyle), just ready for press, is on this subject. Her latest published experimental paper (with E. Rowatt) was on the bacterial synthesis of acetylcholine.

During the Second World War, Dr. Stephenson carried out (with R. E. Davies) some important research on the acetone–butanol fermentation, and took a very active part on the Medical Research Council Committee for Chemical Microbiology.

Throughout her years in the Cambridge Biochemical Laboratory, Dr. Stephenson was greatly sought as friend and adviser. She was always ready to pay sympathetic attention, and her advice, usually given quickly and with decision, was based on a deeply considered philosophy of life. One of her great characteristics was her intense interest in people, and a favourite theme in her conversation was the influence of character upon scientific achievement or, conversely, the effect of certain types of results upon the psychology of research workers. She had many interests outside biochemistry, and this fascination by human nature was very plain in her love of the drama and the great nineteenth-century novelists; she was enthralled, too, by the history of the development of civilization and by certain aspects of the theory and history of science. She used to say that, when her laboratory life was ended, she would like to use the leisure of retirement to write biographies of a few of the men of science (Pasteur and Hopkins among them) whom she so greatly admired, and whom she felt that she in some degree understood. In one of the last conversations I had with her, the subject of present-day growing-points in science came up. It was characteristic of her to say: "Let us consider: if Hoppy had started research in Cambridge to-day instead of fifty years ago, where would he have chosen to begin?"

In her later years her interests seemed to grow wider. She had always loved gardening, and she became very keen on horticultural research. She was greatly concerned about the development of biochemical training in general in Great Britain; she was a great advocate of decentralization, and liked to see good workers from more remote places return to act as foci of progress in their own country.

One of her great qualities was her hatred of any form of cant, hypocrisy, pretention or slovenliness; she was ruthlessly outspoken in her condemnation of any such suspected defect. But this personality, so lively and so gifted with the capacity for leadership, had another characteristic: a fundamental humility, which enabled her to listen, learn, and, if need be, change her mind. She had, lastly, a great opinion of the possibilities of youth, and when the risk was debated of entrusting responsibilities to the young, her advocacy was always on their side. She would have applauded Confucius when he said: "The rising generation is to be respected. Who knows what they may accomplish?"

DOROTHY M. NEEDHAM

Mr. T. Petch

MR. TOM PETCH, the well-known mycologist, died at North Wootton, King's Lynn, on December 24 at the age of seventy-eight, after a short illness. Born at Hornsea and brought up at Hedon, he attended the choir school of Holy Trinity, Hull. From Hull and from Yorkshire naturalists he early acquired great interest in plant and animal life, and contributed many original observations to *The Naturalist* and to the Hull Scientific and Field Naturalists' Club.

As a young man Petch taught science and mathematics at King's Lynn Grammar School, and by dint of private study graduated in both arts and sciences at the University of London. At King's Lynn he came under the stimulating influence of the late Dr. C. B. Plowright, then in the very front rank of students of the fungi, and it was this happy contact that led Petch to devote chief attention to the study of these organisms. Later, he taught at the Leyton Technical Institute. One of his friends at this time was the late Mr. George Massee, of Kew, through whom in 1905 Petch was offered the post of Government mycologist in Ceylon at the Royal Botanic Gardens, Peradeniya. He accepted enthusiastically because the post promised greater scope for his interests.

Petch's arrival in Ceylon coincided with a great extension of rubber plantations. He studied in detail the fungus diseases of the rubber tree, then beginning to cause concern, and his researches in this field were most illuminating. In 1911 he published "The Physiology and Diseases of *Hevea brasiliensis*", and in 1921 "The Diseases and Pests of the Rubber Tree", for many years the best books on the subject, acclaimed by men of science and planters alike. He also gave much attention to the diseases of other crops, notably coco-nuts and tea. His book on the "Diseases of the Tea Bush", published in 1923, is a comprehensive account of the pathology of this plant and is still the standard work.

In 1925 Petch left Government service to become the first director of the new Tea Research Institute of Ceylon, which he launched with great success. Being a man of wide vision, he realized that there were many problems in tea production besides the incidence of disease, so he gathered around him a team of experts competent to explore the whole field of inquiry. Petch had the great gift of inspiring enthusiasm and harmony among his colleagues and confidence among the planters. Both the tea and rubber plantation industries are under a deep debt of gratitude to him for most valuable services.

Petch also devoted much attention to the general study of the fungi, mycetozoa, and flowering plants of Ceylon, for he was no mean botanist as well as a brilliant mycologist. For several years he edited the *Annals of the Royal Botanic Gardens, Peradeniya*, which contains numerous contributions from him, among them being "The Mycetozoa of Ceylon", "The Fungi of Certain Termite Nests", "The Phalloideæ of Ceylon", "Revisions of Ceylon Fungi", "Additions to Ceylon Fungi", and "Studies in Entomogenous Fungi". He left Ceylon in 1928 with the reputation of being the world's foremost tropical mycologist.

On retirement to England, Petch devoted the remaining twenty years to the study of fungi, chiefly British groups. His only other major interest was his large garden at North Wootton, which had been designed by the late Dr. C. B. Plowright. Petch was still a most ardent collector and investigator of micro-fungi, and a constant stream of papers emanated from him, published chiefly in the *Transactions of the British Mycological Society*. Among them may be mentioned "British Hypocreales", "British Nectrioideæ", "British Entomogenous Fungi", and a long series on other entomogenous fungi. One of his last efforts was to compile, with Dr. G. R. Bisby, a revised list of Ceylon fungi. Petch had numerous mycological correspondents throughout the world, whom he was always ready to help. He was a most versatile, careful and critical worker, and he corrected many errors of description and nomenclature made by others.

Unfortunately, few honours came Petch's way; but one which he much appreciated was the conferment of honorary membership of the British Mycological Society, of which he had been president in 1920. He was also president of the Yorkshire Naturalists' Union in 1931. Petch was a Yorkshireman of decided but completely honest views, the staunchest of friends, and a most interesting companion.

Petch married in 1908 the daughter of the late Dr. C. B. Plowright, of King's Lynn, who survives him, together with a son and a daughter. His extensive mycological collections have been bequeathed to the British Museum (Natural History).

F. T. BROOKS

M. Georges Truffaut

BY the sudden death in September last of M. Georges Truffaut, science has lost an international figure. Married to an Englishwoman, he spent much time in Britain during his younger days, and frequently visited Rothamsted, East Malling, Long Ashton and Cheshunt. From each of these he gathered much that interested him, and he created at Versailles a laboratory in which he conducted much research on partial soil disinfection, in which he was inspired by the ideas of Sir John Russell. He investigated the bacterial fixation of nitrogen under the influence of electric light, work initiated, or at least inspired, by his work at Rothamsted, and later, in his Versailles laboratory, his attention was led towards the use of colouring matters, at first in agriculture and later in horticulture.

Truffaut was early involved in the determination and use of various colouring matters as weed eradicants. In 1936 he was invited by the Royal Horticultural Society to visit London to put forward the results of his work, at a time that the utilization of 'Sinox' was still in its infancy. As things turned out, he and his laboratory were not able to carry out the extension of their programme as was done in the Anglo-Saxon countries, but they contributed to the development of the processes to the full measure of their abilities. In his last days Truffaut was occupied in working out a new formula for weed eradication which was more economic as well as more active; but his death occurred before these could be put forward. Had he lived, we should probably have heard more of him and his work in connexion with weed eradication.

WE regret to announce the following deaths:

Dr. Andrew Connal, O.B.E., formerly director of the Medical Research Institute, Lagos, on January 26.

The Right Hon. Lord Melchett, formerly deputy chairman of Imperial Chemical Industries, Ltd., on January 22, aged fifty.

Prof. John Percival, emeritus professor of agricultural botany in the University of Reading, on January 26, aged eighty-five.

NEWS and VIEWS

Chemistry at the Australian National University: Prof. Adrien Albert

DR. ADRIEN ALBERT has been appointed the first professor of chemistry in the John Curtin School for Medical Research, Australian National University. Arrangements have been made for the Department of Chemistry to be located temporarily in the Wellcome Research Institution, 183 Euston Road, London, N.W.1, until the necessary buildings have been erected in Canberra, when Prof. Albert will supervise their completion and equipment. Prof. Albert graduated in the University of Sydney in 1932 with honours in chemistry, and in 1937 was awarded the degree of Ph.D. of the University of London. He returned to Australia in 1938 as a research fellow in the Organic Chemistry Department of the University of Sydney, where he remained until 1947. He has recently held a research fellowship at the Wellcome Research Institution.

Defence Services Research Facilities Committee

AT the invitation of the Council of the Royal Society, the Lords Commissioners of the Admiralty, the Army Council, the Air Council and the Ministry of Supply have appointed representatives on a Defence Services Research Facilities Committee. The terms of reference of the new Committee are as follow: "To consider proposals for the use of Service facilities and personnel for assisting scientific research, and to make recommendations to the Council of the Royal Society, the Lords Commissioners of the Admiralty, the Army Council and the Air Council". The Committee has been constituted as follows: *Chairman*, Sir Geoffrey Taylor; *Royal Society*, Prof. P. M. S. Blackett, Sir Harold Spencer Jones, Dr. A. C. Menzies, Mr. F. S. Russell; *Admiralty*, Vice-Admiral A. G. N. Wyatt (hydrographer), Mr. F. Brundrett (C.R.N.S.S.); *War Office*, Lieut.-General Sir Kenneth Crawford (D.C.I.G.S.), Dr. O. H. Wansbrough-Jones (scientific adviser to the Army Council); *Air Ministry*, Air Vice-Marshal C. E. N. Guest (assistant chief of Air Staff—Operations), Mr. G. S. Whittuck (head of S.6); *Ministry of Supply*, Dr. F. J. Wilkins (principal director of scientific research—defence), Mr. H. M. Garner (principal director of scientific research—air).

The Committee proposes to conduct its business through panels of scientific men and Service representatives who are specially interested in specific projects, and at its first meeting panels were formed to cover the following subjects: (*a*) submarine gravity measurements, (*b*) surplus explosives, (*c*) magnetic survey, (*d*) aerial photography, (*e*) scientific expeditions. Scientific workers wishing to submit proposals for consideration by the Committee should communicate their suggestions in the first instance to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Giant Sunspot and Geomagnetic Storm

A VERY large group of sunspots of 'bipolar' type crossed the solar disk during January 16–29. At central meridian passage on January 22·7 U.T., the middle of the group passed 28° above the centre of the disk. Two big spots were the chief components, with their centres separated 12° in longitude, or approximately 85,000 miles. The aggregate area of the spots for several days was about 2,300 millionths of the sun's hemisphere, or about 55 times the cross-section area of the earth. Greenwich data show that sunspots of this order of size are very likely to be associated with geomagnetic storms beginning within the time-limits of two days before and four days after central meridian passage of the spot group. A severe geomagnetic storm did, in fact, occur, commencing abruptly on January 24 at 18h. 28m. U.T. The disturbance continued with even increased vigour to the night of January 25–26. Displays of the aurora were widely seen on both nights in Great Britain. Provisional overall ranges recorded at Abinger of the earth's magnetic elements (kindly communicated by the Astronomer Royal) are as follow: D, 1° 29′ ; H, 660 γ ; V, 490 γ. Long-distance radio-communication was seriously affected during the period of the geomagnetic storm.

Although a close connexion between the magnetic storm and the solar region containing this giant spot group can scarcely be doubted, there is little evidence at present for the occurrence of a brilliant solar flare some 24 hours before storm onset. Such a flare may have occurred, however, during the Greenwich night hours, and observations are being sought from observatories recording during 18h.–0h.–6h. U.T. either (*a*) direct solar observations; (*b*) radio anomalies that occur in the earth's day hemisphere when flares occur; or (*c*) a characteristic 'crochet' impulse on magnetograms that likewise betrays the occurrence of the more intense flares. Apart from this, there is increasing evidence that the stream of solar particles involved in the occurrence of a great magnetic storm is ejected at the time of an intense flare within the central region of the sun's disk.

Geological Survey in the British Commonwealth

In an article in the *Petroleum Times* of January 1949, a "Petroleum Geologist" puts forward proposals for a British and Commonwealth plan for a modern geological survey. He lays emphasis on the fundamental importance of geological survey, and on the urgent need for an appraisal of the mineral resources of the Commonwealth. He recognizes that the development of the surveys depends on the expansion and training of staff and on the provision of specialist services in such fields as palæontology, geophysics and air survey. The lay-out of the organisation which he advocates accepts the essential independence of the surveys of the several Dominions, but involves a closer relationship between the Geological Survey of Great Britain and the Colonial geological surveys; he proposes that these should be placed under a Minister (or his nominee) with an advisory board, and that specialist services should be joint. The comparison with the organisation of some oil companies is not helpful, however; both in Britain and in the Colonies, geological surveys have a much wider range of interest than an oil company, and procedures suitable for the rapid exploration of oil resources are not necessarily adaptable for a survey which, to be economical, must deal concurrently with many topics. Moreover, while it is true that greater freedom of interchange between Britain and the rest of the Commonwealth is valuable, the differences in the nature of the problems met with, and the importance of individuals with great local knowledge, limit the possibilities of useful interchange. We believe that the Geological Survey of Great Britain is itself as fully engaged on economic problems as "Petroleum Geologist" could desire, while the new organisation of the Colonial surveys promises important and rapid progress as men can be recruited.

Autumn Bird Migration in Britain

Several very interesting items occurred during the autumn of 1948 with bird movements in Britain. On August 21 and 22 an American greater yellowshank (*Totanus melanoleucus*), the sixth British record, appeared at Ecton Sewage Farm, Northamptonshire, where a grey phalarope, the first county record since 1902, and an osprey appeared in September. On September 13 an American pectoral sandpiper (*Calidris melanotis*) appeared at Salthouse Marsh in Norfolk, another was reported from Sinderland, in Cheshire, on September 10, and a third at Thorney Island, Sussex, on October 3. On September 9 an immature cormorant (*Phalocrocorax carbo*) with four legs was obtained at Seaforth, Lancashire; later it died in Liverpool, but X-ray and other photographs were taken for the Merseyside Naturalists' Association. A grey phalarope also appeared at Worsley Sewage Farm, Lancashire, on September 5. On November 11 a little bunting (*Emberiza pusilla*) was added to the bird records of Cumberland by R. Stokoe, a careful observer, at a roadside pool at Siddick, near Workington. Whooper swans were on the same water, and earlier that month on Derwentwater. A gadwall was shot at Frodsham, Cheshire, early in December. Ringed bird returns have included this season a turnstone in Cheshire, marked by Stavanger ornithological station in Norway; and a Manx shearwater found at Leigh, Lancashire (an inland location), on September 5, was marked at the Skokholm colony, South Wales, as recently as August 28.

The Animal Health Trust

Reviewing the ten-monthly period ending June 1948, the second report of the Animal Health Trust describes the completion of the requisition of land and buildings for the Trust's Canine Research Station at Newmarket and the Farm Livestock Research Station at St. Ives. At the former, research has been restricted to studies of a clinical nature including para-distemper, night blindness and Scotch cramp, while at the Poultry Research Station, established on the fifty-acre parkland adjoining Houghton Grange, St. Ives, diseases of the respiratory track have been the priority subjects of investigation. Progress has also been made in the investigations being carried out at the Equine Research Station at Balaton Lodge and Lanwades Park, Newmarket, into infertility, parasitology and diseases of foalhood. During the ten months, the Trust has granted a number of research fellowships to individual workers who wished to continue investigations of an independent nature, and helped some veterinary surgeons to go abroad to widen their experience. Six county committees of the Trust have been formed and eleven others are in the process of being established.

Zoological Society of Bengal: New Journal

Zoologists will be interested in the appearance of vol. 1, No. 1 of the *Proceedings of the Zoological Society of Bengal*, which, it is announced, will be published twice yearly and will contain the results of original research in the various branches of zoology. The first number (obtainable from the Society at 35 Ballygunge Circular Road, Calcutta; price 5 *Rs.* or 10*s.*) comprises 78 pages and 4 plates; and it contains eight papers covering a wide field, contributed mainly by the Department of Zoology of the University of Calcutta. S. P. R. Chaudhuri and I. Bose give an account of meiosis in diploid and tetraploid spermatocytes of the grasshopper *Attractomorpha* sp., while meiosis and chiasma formation in another grasshopper, *Tristria pulvinata*, is the subject of a paper by M. K. Dutt. In a study of the scales in *Glossogobuis giuris*, S. Mookerjee shows that the ctenoid condition is an advance on the cycloid which occurs earlier in development. The bionomics and reproduction of another fish, *Ophicephalus striatus*, are discussed by H. K. Mookerjee, D. N. Ganguly and R. N. Bhattacharya, and R. P. Dhar contributes a hæmatological note on a closely allied species. Some myxosporidians parasitic in fishes are described by M. Chakravarty and S. P. Basu. Termite control with various insecticides tried out in the field is the subject of an investigation by D. Mukerji and P. K. Mitra, and the final paper, concerning the development of the vertebral column in *Alligator mississippiensis*, is by H. K. Mookerjee and R. N. Bhattacharya. Text and figures are clearly printed on good art paper.

Preslia: Botanical Research in Czechoslovakia

THE Czechoslovak Botanical Society has just published a comprehensive issue (vols. 22 and 23, pp. 248) of its proceedings, *Preslia*, for the years 1943–47. The periodical, named after the brothers J. S. and K. B. Presl, who flourished in the first half of the last century, had been an annual publication for some time before the War, but nevertheless served as a repository for the results of botanical research in Czechoslovakia. The Society now has an active membership of more than two hundred, besides that of some twenty-nine (pre-war, thirty-seven) affiliated societies and naturalists' clubs. During the period under review it was mainly through these that botanists were able to continue working and publishing. The current issue of *Preslia* lists these contributions for the years 1939 to 1947 as well as describing (in English and Czech) the recent history of some of the affiliated institutions. Some institutes are still not in working order. Dr. I. Klašterský is held up with his work on the genus *Rosa*; Prof. J. Peklo lacks facilities for his phytopathological studies, and Prof. K. Domin cannot obtain the foreign literature he needs for comparative purposes. So far as botany is concerned, Slovakia appears to have suffered less than Bohemia, though Prof. B. Němec states that the Bratislava University Institute for Plant Physiology lacks microscopes and other equipment, and is without a proper library. A note in *Preslia* refers to the failure of the Botanical Society to obtain a grant from Unesco through the Association Internationale des Microbiologistes, and this is likely to delay further publication. In 1938 a group of botanists founded a journal, *Studia Botanica Cechoslovaka*. It survived until 1943, and hope is now expressed that it will resume publication under the editorship of Prof. S. Prát and Dr. I. Klašterský.

Toxicity of Certain Synthetic Organic Compounds to Insects

THIS subject is discussed in the *Canadian Journal of Research*, June 1948, in a paper divided into two parts. In Part 1 Messrs. A. W. A. Brown, D. B. W. Robinson, H. Hurtig and B. J. Werner record their results from testing the general toxicity of some 127 synthetic compounds when mixed in graded concentrations in the food of the larvæ of the housefly (*Musca domestica*), the confused flour beetle (*Tribolium confusum*), the Mediterranean flour moth (*Ephestia Kuhniella*) and adults of the granary weevil (*Sitophilus granaria*). Each compound was intimately mixed with the food medium in which each of the foregoing insects lives and feeds. The method of testing gives an overall measure of the contact, stomach, and fumigant action of each compound without distinction as to its mode of action. The most highly toxic substances were found to be 'Gammexane' (the gamma isomer of hexachlorocyclohexane) and chlordane (obtained by the distillation of technical chlordane). The toxicity of D.D.T. was, on an average, one half of that of these two compounds. In Part 2 Messrs. A. W. A. Brown, B. J. Werner and F. E. Park record the results of their experiments regarding the direct toxicity of 91 compounds against the nymphs of the German cockroach (*Blatella germanica*) and of the large milk-weed bug (*Oncopeltis fasciatus*), continuously reared in the laboratory on seeds of *Asclepias syriaca*, and also adults of the confused flour beetle (*Tribolium confusum*). The compounds used were dissolved in graded concentrations in a benzine-kerosene mixture and sprayed on the insects confined in a cylindrical glass spraying tower 29 in. high. Compressed air was applied to an atomizer at a uniform pressure of 23 cm. mercury. Taking the results with the three species of insects as a whole, the highest contact toxicity was shown by 'Gammexane' and chlordane. Dinitro-*o*-cresol and dinitrocyclohexylphenol were next in order of effectiveness. The results described in the two parts of this paper are based on tests carried out at the Experimental Station, Suffield, Alberta.

International Veterinary Congress

THE Fourteenth International Veterinary Congress will take place in London during August 8–13, 1949, and the meetings will be held at the Central Hall, Westminster, and in Church House, Westminster, S.W.1. The Duke of Gloucester, who is the president of the Royal Veterinary College and Hospital of London, hopes to be able to open the Congress. As it is considered that the present world food situation is the most important scientific and practical question of the day, the programme of the Congress has been based on this theme. Every morning there will be a plenary session at which a paper will be presented by a leading authority on the veterinary profession's contribution to some aspect of world food production. Sectional meetings will be held in the afternoons, and the programme for these is designed to cover a wide range of subjects. The executive committee has been appointed as follows: *President*, Sir Daniel Cabot; *vice-president*, Prof. J. B. Buxton; *honorary secretary*, Dr. W. R. Wooldridge; *honorary treasurer*, Mr. G. N. Gould; *general secretary*, Mr. W. G. R. Oates. An exhibition of the latest instruments, appliances, drugs, disinfectants, books, etc., will be arranged near to the Central Hall. Social functions have been arranged for the evening of August 7, and during the week of August 15–20 excursions will be made to places and establishments of veterinary interest. Official invitations to the Congress have been issued by the Government of Great Britain to foreign, Commonwealth and Colonial Governments. Representation has been invited not only from government veterinary departments, but also from universities, veterinary schools and other interested bodies in every country. Persons desirous of attending the Congress should apply as early as possible, and all inquiries should be addressed to the Organising Secretary, Fourteenth International Veterinary Congress, 10 Red Lion Square, London, W.C.1.

Fourth Empire Mining and Metallurgical Congress

A NOTE on the coming Fourth Empire Mining and Metallurgical Congress has already been published in *Nature* (October 16, p. 606). A second circular on this Congress is now available, and in it details are to be found relating to the inaugural programme in London for July 9–12 and to the technical sessions to be held in Oxford during July 13–17. In Oxford the main subjects for discussion will be: mineral resources of the Commonwealth; modern methods of prospecting; physiological and psychological effects of heat and humidity on workers in deep mines and in metallurgical works; petroleum—with special reference to the world oil position, oil-well drilling practice and its application to petroleum exploration; coal—with special reference to resources of the Commonwealth, the characteristics of Empire coals and modern coal-mining practice in Great Britain; present-day trends in mineral dressing; and metallurgy and metallurgical industries. Also in this circular full details are given of the excursions during July 18–23. The programme consists of visits, based on Cardiff, Cornwall, Edinburgh, Manchester, Newcastle-upon-Tyne, Sheffield and Stratford-upon-Avon, which will be made to collieries, iron and steel works, hydro-electric schemes, shipbuilding yards and other places of technical interest, together with a number of excursions of historical and general interest. Further information may be obtained on application to the Joint General Secretaries, Fourth Empire Mining and Metallurgical Congress, 436 Salisbury House, Finsbury Circus, London, E.C.2.

Applications of Ultrasonics

THE Acoustics Group of the Physical Society has arranged to hold a discussion meeting on the applications of ultrasonics at th Imperial College, London, S.W.7, at 2.15 p.m. on February 18; Mr. G. Bradfield will read a review paper and Mr. J. M. M. Pinkerton will outline the application of ultrasonics to the investigation of molecular structure. These papers will be followed by sixteen invited contributions covering the majority of present applications: other workers in supersonics who may wish to contribute should write to the Joint Honorary Secretaries of the Acoustics Group of the Physical Society, 1 Lowther Gardens, London, S.W.7.

Committee on Exports and Imports of Cattle Semen

THE Minister of Agriculture and Fisheries and the Secretary of State for Scotland have appointed a Committee with the following terms of reference: "To advise on the considerations which should govern the granting of licences for the export and import of cattle semen for the purposes of artificial insemination and on any other problems related thereto". The Committee is constituted as follows: Lord Oaksey (*chairman*), Col. S. E. Ashton, Sir John Barlow, Dr. J. Hammond, Mr. E. O. Jones, Mr. Alexander Keith, Prof. W. C. Miller, Mr. Duncan M. Stewart, Mr. W. R. Trehane and Mr. W. J. Wright. The secretary to the Committee is Mr. R. Harding Wynne of the Ministry of Agriculture and Fisheries, 14 Chester Terrace, Regent's Park, London, N.W.1.

Science Masters' Association: Scottish Branch

THE annual general meeting of the Scottish Branch of the Science Masters' Association will be held in St. Leonard's School, St. Andrews, during April 12–14, under the presidency of Sir James Irvine. The principal speakers will be Prof. John Read, Prof. A. D. Peacock, Dr. Freundlich and Dr. Steel. They are to give addresses on "Giant Molecules", "Darwinism Up-to-Date", "The Problem of Evolution in Astronomy" and "Tidal Power", respectively. Visits have been arranged to the works of the Cash Register Co., Guardbridge paper mills, the sugar beet factory at Cupar, and elsewhere. Publishers and scientific instrument makers are also taking part.

Announcements

SIR WALLACE AKERS, a director of Imperial Chemical Industries, Ltd., has been appointed a trustee of the National Gallery.

IT is announced from the University of London that Mr. Ronald King has been appointed to the University readership in physics tenable at University College as from January 1. The following doctorates have been conferred: *D.Sc.*, Mr. Hans Grüneberg (reader at University College), Mr. S. E. Jacobs (Imperial College), Mr. R. C. Jordan (Imperial College); *D.Sc.* (*Econ.*), Mr. S. M. Dhumé (London School of Economics).

A NEW open scholarship, worth up to £1,000, is being offered by the Textile Institute, and applications are invited both from those already engaged in the textile industry and from those still at school who propose to study textile technology. The scholarship is intended to provide facilities for a three years course of study in textile technology to an advanced stage and for industrial experience in Great Britain and abroad. Details and application forms are available from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester, 3.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, 1949, a limited number of postgraduate scholarships in husbandry, agricultural economics, statistics, and agricultural and dairy engineering. The closing date for applications is May 15, 1949. Further particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 1/4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh, 1, according to the country of residence. Applicants resident in Northern Ireland should apply to the Ministry of Agriculture and Fisheries, London, at the above address.

A CONFERENCE on Mental Health will take place at Seymour Hall, Seymour Place, London, W.1, on March 17 and 18, 1949. Applications for tickets and all correspondence should be addressed to the Conference Secretary, 39 Queen Anne Street, London, W.1.

THE date of the Fifth International Congress of Comparative Pathology in Istanbul (see *Nature*, November 27, p. 844) has been put forward to April 22–29, 1949.

REFERRING to his article on "Ancient Arts and Modern Parodies" in *Nature* of January 22, p. 146, Mr. William Fagg states that the last sentence of the second paragraph should read, "Less easy to explain is the omission of the truly primitive sculpture of Borneo . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Elementary Particles and the Principle of Reciprocity

THE discovery of different kinds of mesons with rest-masses spreading over a considerable range has brought about a fundamental change in the aspect of the problem of elementary particles. It looks as if there exists a great many, possibly an infinite number of particles with different rest-masses, most of them being unstable, while a few have a long life-time. So long as one had to deal only with a small number of particles, the electron, nucleon (proton–neutron), and Yukawa's meson, it was appropriate to treat each of them separately and to describe them by wave equations constructed according to the more or less known properties (rest-mass, spin) of the particles. This procedure has now become inadequate; one has to face the problem of the inter-relation of the particles and in particular of their rest-masses. The safest course to take would, of course, be to wait until enough experimental material has been accumulated for building a reliable theory on it. Yet I think that preliminary work can be done now, namely, a discussion of the type of theory which could deal with the situation.

Each kind of particle is associated with a field (photon-Maxwell field, electron-Dirac field, meson-Yukawa field, etc.), satisfying a set of wave equations. Instead of these equations one can use the corresponding Lagrangian density L, the form of which depends on the spin, the rest-mass being the essential characteristic constant. If L is known, the field equations can be established; the solution of these are the wave functions ψ which determine the behaviour of the particles.

While the determination of ψ from a given L is the central problem of our present quantum mechanics, the new experimental situation demands a change of attitude: L itself becomes the unknown function. One needs, therefore, a general principle which determines the possible L's in regard to their spin-structure and rest-mass constant.

Some years ago, I suggested a very general principle, called the postulate of reciprocity, which states that the ultimate laws of physics should be symmetric in space-time x^k and momentum energy p_k ($k = 1, 2, 3, 4$). The evidence for this hypothesis is slender; it consists in the formal fact that this symmetry appears in the basic law of quantum mechanics, the commutation rule $x^k p_l - p_l x^k = i\hbar\delta_{kl}$, and in some other important concepts like the angular momentum. Further, many facts indicate the existence of a universal length a; then Planck's constant splits up into a product, $\hbar = ab$, where b is a universal momentum (or, for $c = 1$, an energy, or a mass). Finally, nuclear physics presents systems where neither a spatial description (allocation of positions to nucleons) nor a purely momental representation is adequate, but a combination of the two.

However, applied to present quantum mechanics (ψ-functions), this principle has not proved to be fertile. There is in Nature no obvious symmetry of the kind postulated. One has to go one step deeper and apply the postulate to the L-functions described above.

Before this could be done, a considerable amount of work had to be carried out in developing the most general field theories possible in such a way that the clumsiness of the usual formalism is avoided. This has been done by my collaborator, Dr. H. S. Green, who will explain his new methods of field quantization in another letter. Here a few points suffice.

Instead of the wave function ψ, there is used the statistical matrix ρ which for pure states reduces to $\psi\psi^*$ but represents also 'mixtures'. The most general Lagrangian of a field can then be written $L = F(p_k, p_k')\rho$, where F is a function of two sets of four variables; both these represent the momentum, but p_k operates on ρ from the left, p_k' from the right. Without going into details, it is only necessary to state Green's extremely simple result, that the field equations can be written in the form

$$F(p_k, p_k)\,\rho = 0. \tag{1}$$

Hence the function $(F p_k, p_k)$, or shortly $F(p)$, is characteristic of a given type of field.

I now propose to apply the principle of reciprocity to this function: only self-reciprocal functions F can be used for describing particles. This in combination with the principle of relativity is, in fact, a powerful instrument for obtaining particles with definite rest-masses. I shall indicate this for the example of scalar fields (spin zero).

A simple way of finding all self-reciprocal scalars is to determine the eigenfunctions of the operator $x^k x_k + p^k p_k$, where the co-ordinates and momenta are measured in the units a and b respectively ($ab = \hbar$). It is easy to see that the relativistic invariant eigenfunctions have the form

$$F(p) = f(P)\, e^{-P/2}, \tag{2}$$

where $f(P)$ are Laguerre polynomials of the argument $P = p_k p^k$. The simplest of these belonging to the eigenvalues 0, 1, 2 . . . are:

$$f_0 = 1, \quad f_1 = P - 2, \quad f_2 = P^2 - 6P + 6. \tag{3}$$

Since the exponential factor in (2) never vanishes, the field equations (1) reduce to

$$f(p)\rho = 0. \tag{4}$$

By factorizing the polynomial $f(p)$, one sees that (4) can be satisfied by plane waves with momentum-energy p^0_k if $P^0 = p^0_k p^{0k}$ is one of the roots of $f(x) = 0$. These roots are positive numbers easily obtained from (3); for example, for f_1, $x_1 = 2$; for f_2, $x_2^{(1)} = 3 + \sqrt{3}$, $x_2^{(2)} = 3 - \sqrt{3}$, etc. If x_r is one of these, one has a wave which satisfies

$$(p_k p^k - x_r)\,\psi = 0; \tag{5}$$

hence the conclusion suggests itself that $\sqrt{x_r}$ is a possible rest-mass.

To show this rigorously one has to investigate whether it is possible to formulate the quantized field theory for any such function in such a way that the total energy and momentum of the field appear in the form

$$P_k = \sum_r n_r p^0{}_k{}^{(r)}, \quad p^{0(r)}\, p^0{}_k{}^{(r)k} = x_r, \tag{6}$$

where the n_r are operators with integral eigenvalues. This has been proved for the most general Lagrangian by Green (see the following letter).

One has therefore already for scalar fields an infinite number of different particles with numerical rest-masses; the lowest are

$$\sqrt{2} = 1{\cdot}414, \quad \sqrt{3+\sqrt{3}} = 2{\cdot}175, \quad \sqrt{3-\sqrt{3}} = 1{\cdot}126, \ldots$$

and their ratios correspond roughly to some experimental results on mesons. But it would be premature to discuss this question.

Lagrangians for particles with spin can be found in a similar way. For example, for spin ½ one obtains, as the simplest self-reciprocal F, Dirac's expression with an exponential factor similar to that in (2).

One can regard the theory suggested here also from quite another angle, namely, as a rational generalization of relativity. Ordinary relativity is based on the invariance of the 4-dimensional distance, or its square $R = x^k x_k$. Can one really define distance of two particles in sub-atomic dimensions independently of their velocity ? This seems to me not evident at all.

The theory proposed here for scalar fields is equivalent to demanding as a fundamental invariant the sum $R + P = x^k x_k + p^k p_k$. For macroscopic bodies, where the p_k are extremely small in our units, this reduces to Einstein's $R = x^k x_k$; on the other hand, for the interior of nuclei, spatial dimensions are negligible and the generalized distance reduces to $P = p^k p_k$. In the general case the eigenvalues of $R + P$ are integers which indicate a kind of discontinuous structure of the x- or the p-space, while the eigenfunctions F determine the dynamical laws. For spin ½ one has to define the distance by taking the root of R and P with the help of properly chosen Dirac matrices.

It remains to consider the problem of interaction. So far as we can see at present, the postulate of reciprocity in conjunction with Green's field theory leads to a rational approach to this problem.

Whatever the success or failure of the special hypothesis suggested here, I am convinced that the quantum theory of particles has to solve the problem of determining Green's F-functions from some general principle.

MAX BORN

Department of Mathematical Physics,
University, Edinburgh.
Nov. 3.

Quantized Field Theories and the Principle of Reciprocity

THE quantum theory of wave fields (reviewed by Pauli[1] in 1941) shows it is possible, starting from a known Lagrangian function L, to calculate the charge-current vector, the energy-energy flux tensor, and the angular momentum tensor for any wave field, and further how to quantize the field in such a way that the charge, energy and momentum of the field are expressed as integral multiples of some elementary units which are associated with the constituent particles of the field. The theory has recently been extended by Chang[2] and de Wet[3] to a more general type of Lagrangian, involving any number of space and time derivatives of the wave vector; the calculations of these authors are, however, so complicated that it is difficult to see how they could be applied, even if any specific application were envisaged, and besides they do not fully satisfy the requirements of relativity.

There is now little doubt that the existence of mesons with several different masses requires a wave equation of the type

$$F(P)\psi = 0, \quad P = p_k p^k = E^2 - p^2, \tag{1}$$

where E is the energy operator $i\hbar\,\dfrac{\partial}{\partial t}$, and p the momentum operator $-i\hbar\,\dfrac{\partial}{\partial x}$, the masses of the different particles being obtained as the roots of the equation $F(m^2) = 0$. (In equation 1 and elsewhere, a repeated suffix (k) is summed from 1 to 4.)

As Prof. Born has proposed, the possible functions F may be determined uniquely by the principle of reciprocity. For the quantization of wave fields described by equations such as (1), the technique of field theory has to be considerably refined. A Lagrangian operator of the form

$$L = F(p_k, p_l')\rho, \quad p_k = i\hbar\,\frac{\partial}{\partial x^k}, \quad p_k' = -i\hbar\,\frac{\partial}{\partial x^{k'}} \tag{2}$$

may be defined, where ρ is the relativistic statistical operator, which is in the co-ordinate representation a function of two complete sets of co-ordinate variables $x^k \equiv (x,t)$ and $x^{k'}$. The operator ρ must be distinguished from the true density operator, to be defined later. The field equations, of which (1) is typical, are then

$$\left.\begin{aligned} F(p_k', p_l')\rho &= (F + \pi_k G^k)\,\rho = 0, \quad \pi_k = p_k' - p_k;\\ F(p_k, p_l)\rho &= (F + \pi_k' G^{k'})\,\rho = 0, \quad \pi_k' = p_k - p_k', \end{aligned}\right\} \tag{3}$$

which serve also to define G^k and $G^{k'}$. The equations of continuity, conservation of energy, energy transport, . . ., are obtained from them simply by multiplying the first by 1, p_k, $p_k p^k$, . . . , and the second by 1, p_k', $p_k' p^{k'}$, . . . , and subtracting, thus :

$$\begin{aligned} \pi_k(G^k + G^{k'})\rho &= 0,\\ \pi_k(F\delta_l^k - G^k p_l - G^{k'} p_l')\rho &= 0, \end{aligned} \tag{4}$$

where $R^k = \frac{1}{2}(G^k + G^{k'})\rho$ is interpreted as the density–flux vector, and $L_l^k = (F\delta_l^k - G^k p_l - G^{k'} p_l')\rho$ as the canonical energy flux tensor. It can be seen, therefore, that R^4 is the true density operator, and that the Hamiltonian energy-momentum vector

$$P_k = \int \tfrac{1}{2}(p_k + p_k')R^4 d\Omega \tag{5}$$

differs in the integrand from L_k^4 only by a space divergence which vanishes on integration over the real space Ω.

The commutation rule has the very simple form

$$\zeta_i R^4 \pm R^4 \zeta_i = \zeta_i, \tag{6}$$

where ζ_i is a creation operator for a particle with mass m_i, and the positive or negative sign is taken according as the particle obeys Fermi or Bose statistics. If ρ is expressed in the form

$$\rho = \sum_{ij} \psi_i(x_k)\,\psi_j^*(x_l'), \tag{7}$$

the rule (6) reduces to

$$\tfrac{1}{2}(G_4 + G_4')\,[\psi_i(x_k), \psi_j^*(x_l')] = \delta(x - x')\delta_{ij}\ (t' = t). \tag{8}$$

From this one can easily show that the field consists of particles with different but definite masses, to each of which can be assigned a definite energy and momentum. One can show further that the energy-momentum operator P_k has the property of the differential operator in commutation with ψ_i, so that the transition to quantum mechanics can now be completed by expressing the field equations in operational form.

This theory is quite general. When applied to Born's self-reciprocal Lagrangians, one obtains immediately the picture of a single quantized wave field in which particles with different rest-masses co-exist without interaction. Particles belonging to different

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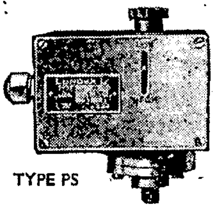

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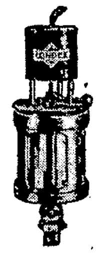

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eigenfunctions F may, however, interact directly, and it appears to be possible to determine the form of interaction uniquely from the principle of reciprocity, restricted only by the requirements of the conservation of charge, momentum and spin (angular momentum) which are consequences of the theory. It can therefore be hoped that the adoption of the principle of reciprocity may lead to a purely deductive theory of the sub-atomic particles in agreement with the experimental facts.

H. S. Green

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Nov. 3.

---

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Low-Temperature Ultra-Violet Absorption Spectra of Biologically Important Compounds

The work of Holiday[1] on the ultra-violet absorption spectra of amino-acids at room temperatures, and of Caspersson[2] and others on the absorption characteristics of biological material, have made clear the importance of this physical approach to the greater understanding of the living cell. It has also been known for a long time that the absorption and fluorescence spectra of solids may sharpen as the temperature is lowered; in the inorganic field this effect has frequently been used in the interpretation of the energy states of ions. The work described in this note is the first step in an investigation of the possibilities of low-temperature microspectrography of biological material as an aid to distinguishing between various important compounds.

Since the work to be described was begun, Loofbourow[3] and others have given evidence concerning the narrowing of the ultra-violet absorption spectia of thymine and tryptophan. Below are given detailed results on the absorption spectra of some purines, pyrimidines and amino-acids at 90° K.

Absorption peaks of sublimed films

Compound	Absorption peaks at room temperature	Absorption peaks at 90° K.
Thymine	2827, 2763, 2709, 2653	2818, 2759, 2704, 2651, 2597, 2546
Uracil	2658, 2543	2859, 2796, 2723, 2650, 2558
Adenine	2868, 2764, 2663	2880, 2829, 2771, 2720, 2669
Guanine	2935, 2775, 2690	2918, 2830, 2774, 2719, 2666
Tryptophan	2998, 2880, 2810	2993, 2931, 2869, 2807, 2739, 2680
Phenylalanine	2693, 2655, 2593, 2535, 2482, 2427, 2222	2691, 2651, 2625, 2589, 2529, 2480, 2423, 2221, 2190

The low-temperature apparatus used was a glass-metal Dewar vessel, the inner metal portion of which consisted essentially of a 'fernico' tube closed at the lower end by a copper block. The 'fernico' alloy seals readily to glass, forming a seal which withstands the thermal strains set up by the cooling liquids used in the experiments. We are indebted to the director of research of the British Thomson-Houston Co., Ltd., for provision of the glass-metal seal. Cells suitable for the examination either of films, or of solutions that form glasses at low temperatures, can be readily interchanged. The cells were designed so as to screw directly into the copper block, which is immediately in contact with the cooling liquid. This apparatus may be used for studies as low as 60° K. The temperature of the specimens was measured by means of a contact thermocouple. With liquid nitrogen in the Dewar vessel, the temperature of films in the holder was 90° K.

A hydrogen discharge lamp was used as a source of continuous radiation, and films of purines, pyrimidines and amino-acids were prepared by sublimation under reduced pressure on to quartz coverslips. The infra-red spectra of films sublimed on to rock salt plates are practically identical with the results obtained from suspension of the same compounds in liquid paraffin. The ultra-violet absorption spectra were photographed in a Hilger medium quartz spectrograph, moving the photographic plate in its own plane by means of a logarithmic cam; this device, due to Holiday[4], shows up weak absorption bands to great advantage.

Figs. 2 and 4 show that although there is some structure in the absorption spectrum of uracil at 90° K., the sharpness of the thymine spectrum is much more marked. From a cytological point of view this difference holds interesting possibilities, since thymine is a constituent base of desoxyribosenucleic acid but not of ribosenucleic acid, and gives much sharper absorption peaks than the other bases (guanine, adenine, uracil) so far studied. These results, together with other work now in progress on tissue slices, indicate the importance of further ab-

Fig. 1. Thymine: room temperature

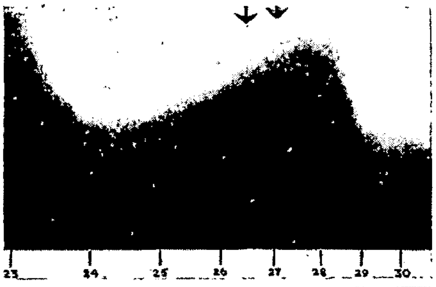
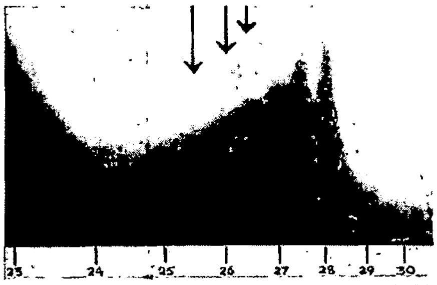


Fig. 2. Thymine: 90° K.



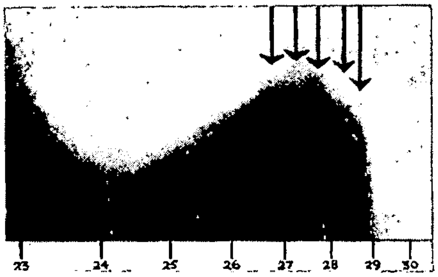


Fig. 3. Adenine: 90° K.

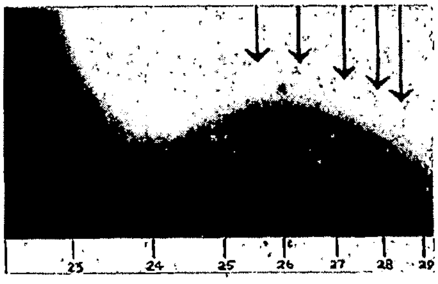


Fig. 4. Uracil: 90° K.

sorption and microspectrographical studies at low temperatures, both on individual compounds and on biological specimens.

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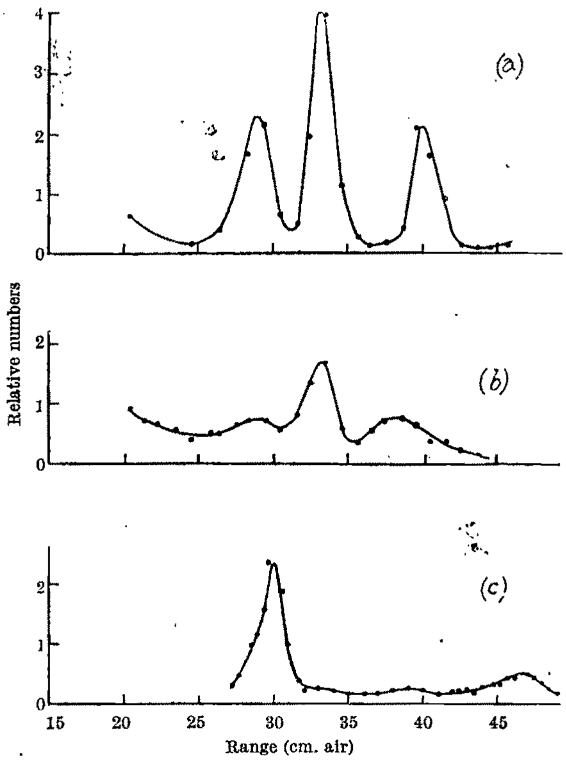
Disintegration of Separated Isotopes of Magnesium by Deuterons

IN a recent study of the transmutation of a number of elements by deuterons[1], the emission of three groups of protons from magnesium under deuteron bombardment was reported. These groups were assigned to particular isotopes by arguments based chiefly on the value of the energy released in similar reactions with other elements and on differences between the excitation functions of the groups. We have now been able to bombard separated isotopes, and the accompanying graph shows the proton groups observed from targets of magnesium-24, -25 and -26 deposited on stainless steel. The deuteron energy was 930 keV. as in the earlier experiments, and the protons were observed at right-angles to the incident beam. The three targets for which the results are shown in the figure were cut from larger areas on which the magnesium was deposited; but since the deposits were not uniform, the target thicknesses could not be accurately estimated. In the case of the magnesium-24 target, observation of the width of a ($p\gamma$) resonance-level suggested an equivalent thickness of about 10 keV.; the thickness of the magnesium-25 and -26 targets was unknown, and the relative intensities of the groups shown in the graph are therefore unlikely to be those which would be obtained from targets in the normal isotopic ratio of thickness.

The earlier interpretation of the proton groups now has to be revised and extended as follows:

Magnesium-24: The groups observed (Fig. *a*) are similar in range and relative intensity to those found from ordinary magnesium targets. The Q-value of 5·03 MeV. previously given[1] for the reaction $Mg^{24}(dp)Mg^{25}$ is therefore confirmed, and the other two groups shown in Fig. *a* indicate excited states in magnesium-25 at 0·58 and 0·98 MeV.

Magnesium-25: We believe that the groups observed (Fig. *b*) from this target are due to contamination by magnesium-24, since they are the same both in range and relative intensity, within the limits of error of the experiment, as those observed from the magnesium-24 target. This has been established by careful counting, under conditions of good geometry and low bias, for several different magnesium-25 targets. There is no evidence for the previous assignment of the 35-cm. proton group to the transmutation $Mg^{25}(dp)Mg^{26*}$, although a small group of this range from magnesium-25 would be obscured by the contamination groups from magnesium-24. The main reason for originally ascribing the 35-cm. group to the transmutation of magnesium-25 was the fact that its excitation function differed strikingly from that of the 32- and 42-cm. groups[1]. Two of us (C. A. W. and C. D. C., unpublished) have since shown that this difference may be explained by variations in the angular distribution of the emitted particles with bombarding energy.



Number-range curves for protons emitted in the bombardment of targets of separated isotopes of magnesium by deuterons: (*a*) Mg^{24}; (*b*) Mg^{25}; (*c*) Mg^{26}. The target thicknesses do not necessarily correspond to the normal isotopic ratio

Magnesium-26: The group of protons of range 32 cm. (Fig. *c*) found from the separated target would not have been resolved in the experiments with ordinary magnesium from the strong group of similar range from magnesium-24. The new group gives a Q-value of $4·21 \pm 0·1$ MeV. for the reaction $Mg^{26}(dp)Mg^{27}$ instead of the value previously quoted of 4·05 MeV. The group of protons at 48 cm. appears on blank targets and could be due to carbon contamination.

The separated targets have also been used to confirm the reaction $Mg^{26}(d\alpha)Na^{24}$ [1]. The 15-hr. activity of sodium-24 was easily observed and followed from the magnesium-26 target after deuteron bombardment, while the activity of this period from similarly bombarded targets of magnesium-24 and -25 was at least ten times smaller.

We are very grateful to Sir John Cockcroft and to Dr. W. D. Allen and members of his group at the Atomic Energy Research Establishment, Harwell, who provided the separated targets used in this work.

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Nov. 19.

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Magnetic Moments of Deuterium-2, Lithium-7 and Fluorine-19

THE exceptionally small natural line-widths obtainable with the magnetic resonance absorption method[1,2] or nuclear induction method[3,4] makes these methods suitable for precision measurements of nuclear magnetic moments. We have constructed an apparatus for this purpose, and have paid special attention to the problem of getting a magnetic field which fulfils the rather extreme requirements of field homogeneity. In this case it was also important that the homogeneity was of such an extension that two different probes could be investigated at the same time on two different places in the field. The pole-pieces of the magnet were 30 cm. in diameter, separated by spacers 4·2 cm. apart. Both the pole-pieces and the spacers were polished optically flat, so that the air gap was the same within 1 μ everywhere.

For the detection of the resonances we have used the balance method first proposed and used by Purcell, Torrey and Pound[1]. The field was carefully mapped by inserting a water probe in the field and observing the difference in resonance frequency for protons in different places. We have been able to find two extremely homogeneous places in the field where resonance absorption simultaneously can be studied, one for protons and the other for the unknown magnetic moment. The homogeneity was such that the line-widths in the two places were about 0·1 gauss. The very small difference in magnetic field between the two places (2 in 10^6) was determined by observing simultaneously the proton resonances in both places.

The signals from the two high-frequency bridges were fed to a double-beam oscillograph, and the two frequencies were adjusted to get the two signals to coincide. Any displacement between the signals on the screen was corrected for by photographing the screen. The total amplitude of sweep on the screen usually corresponded to about 0·3 gauss and was synchronized with the modulation of the magnetic field.

Table 1

Magnetic field (in gauss)	ν_D (in Mc.)	ν_P (in Mc.)	$\frac{\mu_D}{\mu_P} = \frac{2\nu_D}{\nu_P}$
about 3530	2·357340	15·356360	0·3070185
,, 5250	3·500000	22·800000	0·3070176
,, 5250	3·500000	22·800000	0·3070176
,, 5700	3·801091	24·761325	0·3070183
,, 5700	3·801073	24·761120	0·3070195

Mean value, 0·3070183 ; maximum error, ± 0·0000015.

Table 2

Magnetic field (in gauss)	ν_{Li^7} (in Mc.)	ν_P (in Mc.)	$\frac{\mu_{Li^7}}{\mu_P} = \frac{3\nu_{Li^7}}{\nu_P}$
about 5800	9·7249	25·0250	1·16583
,, 5900	9·7778	25·1615	1·16581
,, 5900	9·7765	25·1575	1·16584
,, 5900	9·7776	25·1604	1·16583
,, 6810	11·2893	29·0504	1·16583
,, 6810	11·2896	29·0501	1·16588

Mean value, 1·16584 ; maximum error, ± 0·00004.

Table 3

Magnetic field (in gauss)	$\nu_{F^{19}}$ (in Mc.)	ν_P (in Mc.)	$\frac{\mu_{F^{19}}}{\mu_P} = \frac{\nu_{F^{19}}}{\nu_P}$
about 4600	18·411164	19·566660	0·940946
,, 4600	18·414476	19·570116	0·940949
,, 4500	18·410958	19·566764	0·940930
,, 4600	18·410966	19·566828	0·940927
,, 4600	18·410985	19·566736	0·940933
,, 5710	22·975250	24·417890	0·940919
,, 5710	22·975350	24·417600	0·940934

Mean value, 0·940934 ; maximum error, ± 0·000015.

Every magnetic moment has been measured several times at different field-strengths. The two frequencies to be compared were measured by a General Radio Frequency Standard (Type 1100-*A*, form 664-*A*), which permits an accuracy of 1 in 10^6 in the frequency determination. Our determinations of the nuclear magnetic moments of D^2, Li^7 and F^{19} are summarized in Tables 1, 2 and 3 (the diamagnetic correction is not included).

All moments are expressed in the proton moment as a unit. For deuterium-2 we obtained $\mu_D/\mu_P =$ 0·3070183 ± 0·0000015; for lithium-7 $\mu_{Li^7}/\mu_P \doteq$ 1·165833 ± 0·000050; and for fluorine-19 $\mu_{F^{19}}/\mu_P =$ 0·940934 ± 0·000015.

All our individual measured values fall inside the limits given here. Only the deuteron moment has been determined before by this method, and our value agrees within the limits of error with the determination by Bitter *et al.*[5] ($\mu_D/\mu_P =$ 0·307021 ± 0·000005), but falls a little outside the value obtained by Bloch *et al.*[6] (0·3070126 ± 0·0000020).

The μ-values of lithium-7 and fluorine-19 have not previously been measured accurately by the new method. The values obtained with Rabi's method[7] (μ_{Li^7}/μ_P = 1·16622 ± 0·00090 and $\mu_{F^{19}}/\mu_P$ = 0·9410 ± 0·0013) are given with considerably higher limits of error, but are consistent with our new values.

A more detailed report of this work will appear in *Arkiv för Mat., Ast., och Fysik.* This investigation has been sponsored by the Swedish Natural Science Research Council.

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Dec. 8.

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Slow-Neutron Capture in Helium

THE cross-section for capture of thermal neutrons in helium according to the reaction

$$He^3 + n \rightarrow H^3 + p + 750 \text{ keV}.$$

has been measured relative to the similar reaction in nitrogen for which the cross-section is given as 1·7 barns[1]:

$$N^{14} + n \rightarrow C^{14} + p + 600 \text{ keV}.$$

Cloud-chamber photographs of the helium reaction by slow neutrons have recently been obtained by Hughes and Eggler[2], who found an energy release of 740 keV. The cross-section for such a reaction might be expected to be large.

Briefly, the method was to compare the counting-rates produced in a gridded ionization chamber filled alternately with atmospheric helium, containing 1·20 × 10^{-6} parts[3] of helium-3, and argon, containing a small known admixture of nitrogen, irradiated in a thermal neutron flux of approximately

10^5 neutrons/cm.^{2}/sec. at the thermal column of the Harwell low-energy pile (G.L.E.E.P.).

The helium used contained 2 per cent of nitrogen, which was removed by passing the gas over a large quantity of activated absorption charcoal. British Oxygen Co. 'oxygen-free' argon was used, containing about 0·3 per cent of nitrogen.

Counts were taken on a differential pulse-height analyser, and a well-resolved energy peak was obtained in each case. In order to eliminate effects due to fast neutron recoils in the abundant helium-4, counts were taken with and without cadmium surrounding the chamber in the helium runs. Counts with cadmium in the argon runs were negligible.

If N_1 is the total counting-rate due to the thermal (n,p) reaction in helium, and N_2 the total counting-rate due to the reaction in nitrogen present in the argon, then, under otherwise identical conditions,

$$\frac{N_1}{N_2} = \frac{\sigma_1 p_1 C_1}{2\sigma_2 p_2 C_2},$$

where σ_1 is the cross-section for the He^3 reaction, p_1 is the total pressure of helium in the chamber, C_1 is the concentration of helium-3 in atmospheric helium; while the corresponding quantities with subscript 2 refer to the N^{14} reaction in the argon, and the factor 2 allows for the fact that nitrogen is diatomic.

The ratio N_1/N_2 in a single such measurement could be obtained to an accuracy of about 2 per cent, the pressures p_1 and p_2 were measured on a calibrated pressure gauge, and the nitrogen content C_2 was known to about 6 per cent from mass spectrometer measurements and has been checked by other means. p_1 was made approximately four times p_2 in order that the proton ranges should be roughly equal in the two fillings.

From several separate determinations, a mean value for the cross-section was found to be

$$\sigma_{\mathrm{He}^3} = (3{,}700 \pm 250) \times 10^{-24} \text{ cm.}^2.$$

This figure is given relative to 1·7 barns for the cross-section of N^{14} and $1{\cdot}20 \times 10^{-6}$ for the helium-3 content of atmospheric helium.

It is believed that all nitrogen was removed from the helium in these experiments, and indeed mass spectrometer measurements have set an upper limit of 10^{-4} parts to the nitrogen content. If this amount were, in fact, present, the above cross-section would be too high by some 6 per cent, which is within the error of the measurement.

In conclusion, we wish to thank Prof. F. E. Simon of the Clarendon Laboratory for lending us a cylinder of atmospheric helium, and Mr. G. H. Palmer for making the mass spectrometer analyses.

A complete account of this work will be given later.

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---

[1] See, for example, *CL*–697, chapter 4.

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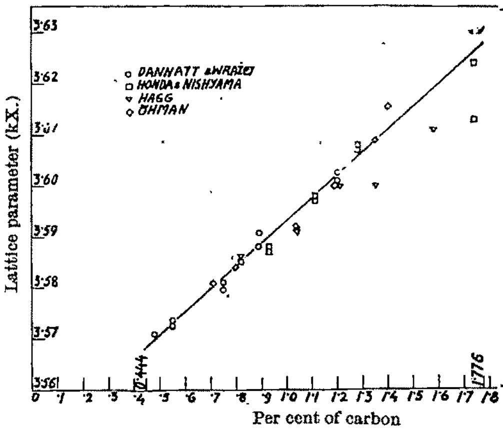
Lattice Spacing of Retained Austenite in Iron–Carbon Alloys

IT is generally accepted that the lattice parameter of retained austenite in quenched iron–carbon alloys increases continuously and linearly with the increase of carbon content. So far, however, the presence of retained austenite has only been recognized when the iron–carbon alloy contains more than 0·6 per cent of carbon[1].

The assumption put forward by me[2] that the gamma solid solution in iron–carbon alloys is composed of pseudo-phases called γG, γS, γE, the amounts of which depend on the carbon content of the particular alloy, makes it possible to assume the existence of retained austenite in quenched alloys containing even less than 0·6 but more than 0·444 per cent of carbon. The examination of alloys in this composition range justifies the assumption.

An accurate measurement, for example, by means of the combined substance method[3] applied to X-ray films, taken from various iron–carbon alloys in quenched condition, confirms the continuous change of spacing of retained austenite to the extent that its regularity enables the determination of the carbon content of a particular alloy to be made.



% C.	kX.
1·776	3·6281
1·70	3·6245
1·60	3·6200
1·50	3·6155
1·40	3·6110
1·30	3·6065
1·20	3·6020
1·10	3·5975
1·00	3·5930
0·90	3·5885
0·80	3·5840
0·70	3·5795
0·60	3·5750
0·50	3·5705
0·444	3·5678

The accompanying graph shows the lattice spacings of retained austenite in iron–carbon alloys determined by various authors[1], including our own measurements[4]. The data shown, and many others collected during the experiments, suggest that there must be a theoretical value of lattice parameter for retained austenite in each of the quenched iron–carbon alloys containing carbon between 0·444 and 1·776 per cent. The most probable values of these can be represented by the straight line, and calculated from the formula:

$$a_\gamma = 3{\cdot}5678 + 0{\cdot}045\,(C - 0{\cdot}44) \text{ in kX.},$$

where 3·5678 in kX. is the most probable spacing of retained austenite in an iron–carbon alloy with 0·444 per cent of carbon, 0·045 is the value of the tangential function, that is, the constant increase in lattice parameter (0·0045 kX.) for 0·1 per cent of carbon, and C is the percentage of carbon in the alloy.

The figures thus obtained for the lattice spacing of retained austenite in a given iron–carbon alloy after quenching make it possible to decide that the measurement of the X-ray film was correct and that the heat-treatment was properly performed.

More detailed data connected with the description of the heat-treated iron–carbon alloys will be published elsewhere.

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Aug. 23.

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Deviation at Vertical Incidence in the Ionosphere

It was pointed out by Booker[1] ten years ago that even at vertical incidence the ordinary and extraordinary rays are deviated in the ionosphere, an effect that may be explained by the change in direction of the associated Poynting vectors. They are deviated in opposite directions from the vertical in the earth's magnetic meridian plane, and at their reflexion points they make angles with the vertical of D and $\tan^{-1}[\sin 2D/(3 - \cos 2D)]$, respectively, where D is the angle that the earth's field makes with the horizontal.

The latter deviation has a maximum value of 19° 28′ when $D = 35° 16′$; but under conditions when the earth's field is within, say, 30° of the vertical, the horizontal distance between the ordinary and extraordinary reflexion points can be as much as 50 km. for the F layer for frequencies close to the ordinary critical frequency. It follows that at times when large horizontal gradients exist in the ionosphere, the electron densities at the reflexion points for the ordinary and extraordinary critical frequencies can be markedly different.

Little mention of this possibility has so far been made in connexion with ionospheric sounding, but it appears that the effect can be large enough to influence the detailed interpretation of vertical incidence records. The deviation of the rays by the magnetic field, and by the horizontal gradient itself, may have an appreciable effect on the separation of the ordinary and extraordinary critical frequencies, and may account in part for the occasions when it differs markedly from its normal value. Alternatively, caution must be exercised, when using the separation as a measure of the gyro-frequency, in interpreting such variations as due to changes in the value of the earth's magnetic field.

In conclusion, we may remark in connexion with ionospheric observations made during an eclipse, when marked horizontal gradients of density must occur near the edges of the totality belt, that this effect may be of significance both with regard to the optimum siting of the sounding station, and to the conclusions drawn concerning the density changes caused by the eclipse.

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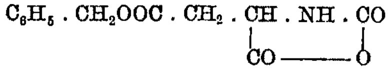
Synthesis of Poly-Aspartic Acid

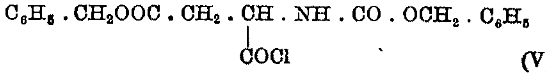
In previous publications we have reported on the polymerization of representatives of normal[1] and of basic[2] α-amino-acids. In the present communication the synthesis of poly-aspartic acid is dealt with as an example of the polymerization of a trifunctional acidic α-amino-acid.

A suitable monomer was found in the N-carboxy anhydride of *l*-aspartic acid β-benzyl ester,



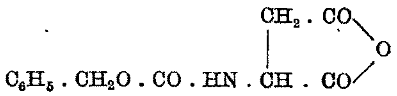
$$\begin{array}{l} C_6H_5\,.\,CH_2OOC\,.\,CH_2\,.\,CH\,.\,NH\,.\,CO \\ \qquad\qquad\qquad\qquad\quad | \qquad\qquad\;\; | \\ \qquad\qquad\qquad\qquad\; CO\text{———}O \end{array} \quad (I)$$

The reversible masking of the β-carboxyl group by the benzyl ester group ensures the exclusive participation of the α-carboxyl group of the aspartic acid in the peptide linking of the monomeric units. The monomer was obtained in the following way. The di-silver salt of N-carbobenzoxy *l*-aspartic acid (II)[3] gave with benzyl iodide in ether N-carbobenzoxy *l*-aspartic acid dibenzyl ester (III); partial hydrolysis by the calculated amount of potassium hydroxide in benzyl alcoholic solution affected the benzyl group attached to the α-carboxyl group only, and yielded the N-carbobenzoxy aspartic acid β-monobenzyl ester (IV). On suitable treatment of the latter with phosphorus pentachloride, the monomer I was obtained. The intermediate chloride (V)



$$\begin{array}{l} C_6H_5\,.\,CH_2OOC\,.\,CH_2\,.\,CH\,.\,NH\,.\,CO\,.\,OCH_2\,.\,C_6H_5 \\ \qquad\qquad\qquad\qquad\quad | \\ \qquad\qquad\qquad\qquad\; COCl \end{array} \quad (V)$$

was not isolated. The results of elementary analysis are consistent with formula I, but do not exclude the isomeric N-carbobenzoxy aspartic acid anhydride (VI)[4],

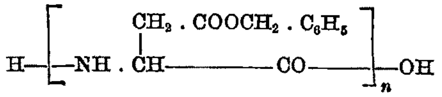


(VI)

the formation of which is also conceivable from (V) on loss of benzylchloride.

Some of the facts which prove that the substance obtained is different from (VI) and correctly represented by formula I are as follow: (i) the melting point found (111°, with evolution of carbon dioxide) is different from that of (VI) (124°)[4], and is depressed by the admixture of a preparation[4] of the latter; (ii) the ninhydrin colour reaction is positive; (iii) on heating, evolution of gas occurred, the loss of weight being in agreement with the calculated value of one mole carbon dioxide per mole of (I); the polymer obtained has the elementary composition to be anticipated in using a monomer of the formula I, and gives a strong biuret reaction.

In accordance with previous experience[2], monomer I was carefully dried in the polymerization vessel in high vacuum, first at room temperature and then at 60°, prior to the polymerization, which was carried out in high vacuum with stepwise raising of the temperature. At 109°, melting occurred with strong evolution of gas, causing a definite increase in pressure. On its decrease, the temperature was raised to 125° and the heating continued until evolution of gas appeared to have ceased entirely. The solid reaction product, giving a strong biuret reaction, is, according to analytical data, the poly-aspartic acid β-benzyl ester (VII):



$$H-\left[-NH\,.\,\overset{\displaystyle CH_2\,.\,COOCH_2\,.\,C_6H_5}{\overset{|}{CH}}\text{————}CO\text{———}\right]_n-OH \quad (VII)$$

Van Slyke amino-nitrogen (manometric) determinations gave values of maximal 0·07 per cent amino-nitrogen, indicating an average chain-length of at least a hundred units and a molecular weight average of at least 20,000.

The corresponding poly-aspartic acid was obtained by treatment of a solution of the poly-ester (VII) in glacial acetic acid with phosphonium iodide in a stream of hydrogen gas. It is slightly soluble in hot water, soluble in dilute alkali.

We found that careful treatment of the poly-aspartic acid ester with normal alkali does not affect the peptide linkages; it appeared, therefore, feasible to obtain the acidic poly-α-amino-acids by eliminating suitably chosen (β- or γ-) ester groups from the respective poly-esters through hydrolysis with dilute alkali instead of the hydrolysis of these (benzyl) ester groups by phosphonium iodide. Experiments on these lines were started some time ago but were interrupted by conditions here.

A polymeric substance, the properties of which suggest peptide structure, was obtained from the product of the reaction of thionyl chloride on N-carbobenzoxy-*l*-aspartic acid (II). On heating this reaction product to 165°, melting occurred with evolution of gas and formation of a glassy mass which gave a positive biuret reaction, a negative reaction for diketopiperazines, and yielded the theoretical amount of aspartic acid on hydrolysis.

On prolonged heating of *l*-aspartic acid at 200° according to Schiff[5], a fraction not mentioned by him, insoluble in hot water, was obtained, giving a positive biuret reaction and having about 1 per cent of its total nitrogen in the form of amino-nitrogen. Hydrolysis of this product leads quantitatively to free aspartic acid. The structure of this polymer has not yet been clarified.

The experiments reported here are part of an investigation (cf. the thesis of one of us (A. B.) for the M.Sc. degree of this University) carried out in 1947. The conditions prevailing in Jerusalem during the present year [1948] have delayed the conclusion of this work.

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Photosensitization by Vat Dyes

IT is well known that cellulose fabrics dyed with certain vat dyes disintegrate on exposure to light[1]. The experimental evidence suggests that a photosensitized oxidation of the cellulose is responsible. It is known that dyes do, in fact, photosensitize a number of reactions[2]; but no systematic survey of the field has been attempted, and the factors which determine the relative efficiencies of different dyes are not known. In a preliminary study of photosensitization, we have found that such dyes can initiate the autoxidation of tetralin, and the polymerization of styrene.

A tungsten filament projection lamp (1 kW.) was used as light source in the polymerization experiments, and a hot mercury arc (350 W.) in the autoxidation. In the latter case the light was filtered through 1 cm. of a 10 per cent solution of ferric alum in 2*N* sulphuric acid to remove light of wave-length less than 3600 A. The rates of reaction relative to pure tetralin and pure styrene are given in Table 1. The figures are approximate only, since many of the dyes fade, especially during the polymerization.

Table 1

Dye	Relative rate of oxidation $pO_2 = 650$ mm. $T = 25°$	Relative rate of polymerization $T = 14°$
Caledon Yellow 5*G*	25	26
Cibanone Yellow *R*	17·8	18·8
Cibanone Orange *R*	10·5	15·5
Cibanone Yellow 2*GR*	7·7	11·4
Caledon Golden Yellow *GK*	5·3	—
Cibanone Orange 6*R*	4·9	6·7
Caledon Red *BN*	2·4	9·5
Caledon Dark Blue *G*	1·2	20·0
Caledon Jade Green *XN*	1·0	5·5
Caledon Jade Green 2*G*	0·9	7·9
Caledon Orange 2*RT*	0·8	—
Caledon Gold Orange 3*G*	0·6	—
Caledon Dark Brown 2*G*	0·1	14·0

In Table 1 the dyes are arranged in order of activity for the autoxidation. This is closely similar to that for the 'tendering' activities of the dyes on cellulosic materials[3]. Both reactions probably have a common origin, namely, the formation of radicals by removal of hydrogen atoms from the substrate by the excited dye. The relative activities in the photopolymerization are not in the same order, and presumably a different mechanism is involved, for example, a direct transfer of energy.

In the case of the autoxidation the general mechanism seems to be established (see following communication), and it is possible to determine the quantum efficiency of the primary process. The following approximate values have been determined for $\lambda = 4500$ A.

Table 2

Dye	Quantum efficiency for sensitization ($pO_2 = 100$ mm.)
Caledon Golden Yellow *GK*	0·0053
Anthanthrone	0·012
Caledon Red *BN*	0·0021

Comparison with Table 1 shows that for the most active dyes the quantum efficiencies must be very high—close to unity.

We anticipate that photosensitization by dyes may have wide applications, and we are at present engaged in their study.

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[1] For recent summary, see Turner, *J. Soc. Dyers and Col.*, **63**, 372 (1947).

[2] Rabinowitch, "Photosynthesis" (New York, 1945).

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Absolute Velocity Constants in the Autoxidation of Tetralin

THE main features of the autoxidation of unsaturated hydrocarbons have been established by Bolland and Gee[1]. The autoxidation of tetralin probably follows a similar course, although the published work[2] is open to criticism. If the kinetic scheme of Bolland and Gee is accepted, dye photosensitization offers a convenient method of determining the velocity constants absolutely. In our programme of work on absolute velocity constants[3], we have therefore studied the sensitized oxidation of tetralin.

This reaction presents experimental difficulties, since it must be studied at oxygen pressures much lower than those used by Bolland. Under these conditions, the rate of solution of oxygen is not sufficient to keep the liquid saturated. Although allowance can be made for this effect in the steady-state kinetics, it is impracticable to determine the life-time of the chains by standard methods, for example, the rotating sector[4]. Moreover, the reaction has an appreciable rate in the dark, even at 25°. In order to determine the absolute velocity constants, it is therefore necessary to obtain alternative relations between the constants to replace those normally derived from the life-time. By following the reaction in a Warburg-type apparatus, and by applying appropriate corrections, we have been able to measure the true photochemical after-effect. We have established that this is due to the finite life of the chains, and is independent of the initiation step; it therefore provides the required relations. It is also necessary to know the absolute rate of chain starting. This was measured by a standard inhibitor method, the validity of which we have proved in this case.

The steady-state kinetics are consistent with the scheme:

$$\begin{array}{llll} D + h\nu \rightarrow D^* & I_{\mathrm{abs}} & T\mathrm{O}_2 + TH \rightarrow T\mathrm{O}_2H + T & k_4 \\ D^* \rightarrow D & k_f & 2T \rightarrow ? & k_5 \\ D^* + \mathrm{O}_2 \rightarrow D + \mathrm{O}_2 & k_1 & T + T\mathrm{O}_2 \rightarrow ? & k_6 \quad (1) \\ D^* + TH \rightarrow DH + T & k_2 & 2T\mathrm{O}_2 \rightarrow ? & k_7 \\ T + \mathrm{O}_2 \rightarrow T\mathrm{O}_2 & k_3 & & \end{array}$$

in which D, TH represent dye and tetralin respectively. For long chains, with the approximation[1] $k_6 = \sqrt{k_5 k_7}$, this leads to

$$-\frac{d[\mathrm{O}_2]}{dt} = \left\{\frac{k_2 I_{\mathrm{abs}} [TH]}{k_f + k_1[\mathrm{O}_2]_l + k_2 [TH]}\right\}^{1/2} \frac{k_3 k_4 [\mathrm{O}_2]_l [TH]}{k_3 \sqrt{k_7} [\mathrm{O}_2]_l + k_4 \sqrt{k_5} [TH]}, \qquad (2)$$

where $[\mathrm{O}_2]_l$ is the concentration of oxygen in the liquid. The term in the first bracket on the right of (2) gives the rate of chain-starting; it will be noticed that at high oxygen pressures the excited dye is de-activated by oxygen. We intend to study this reaction in more detail. The after-effect, $\Delta[\mathrm{O}_2]$, is given by

$$\Delta[\mathrm{O}_2] = \frac{k_3 k_4 [\mathrm{O}_2]_l [TH] \{k_3[\mathrm{O}_2]_l + k_4[TH]\}}{\{k_3 \sqrt{k_7} [\mathrm{O}_2]_l + k_4 \sqrt{k_5} [TH]\}^2} \log \tfrac{1}{2} (1 + \xi), \qquad (3)$$

where ξ is the ratio of the photochemical and thermal rates. If the reaction has no thermal rate, an analogous expression for $\Delta\mathrm{O}_2$ may readily be deduced, but it is more convenient to provide a 'thermal' rate by continuous weak illumination.

Since the rate of chain-starting is known, equations (2) and (3) each provide two relations between the velocity constants k_3, k_4, k_5, k_7. The values obtained for these constants at 25° were $k_3 = 6{\cdot}8 \times 10^7$, $k_4 = 13{\cdot}3$, $k_5 = 7{\cdot}1 \times 10^6$, $k_7 = 2{\cdot}2 \times 10^7$ litre mol.$^{-1}$ sec.$^{-1}$. From the variation of rate with temperature, the following differences of activation energies were found:

$$\begin{aligned} E_4 - \tfrac{1}{2}E_7 &= 4{\cdot}3 \text{ kcal.} \\ E_3 - \tfrac{1}{2}E_5 &= -1{\cdot}5 \text{ kcal.} \end{aligned} \qquad (4)$$

From the temperature coefficient of the after-effect at high oxygen pressures, E_4 was found to be 4·2 kcal. Unfortunately, the results at low oxygen pressures were not sufficiently accurate to allow E_3 and E_5 to be determined separately. However, it is unlikely that E_5 is appreciably greater than 2·8 kcal., the value for the termination reaction between similar radicals in the polymerization of styrene[3], and from (4) it cannot be less than 3 kcal.

The following table summarizes these conclusions. Activation energies are probably correct to 1 kcal.

$E_3 = 0$ kcal.	$A_3 = 6{\cdot}8 \times 10^7$
$E_4 = 4{\cdot}3$,,	$A_4 = 1{\cdot}8 \times 10^4$
$E_5 = 3{\cdot}0$,,	$A_5 = 1{\cdot}1 \times 10^9$
$E_7 = 0$,,	$A_7 = 2{\cdot}2 \times 10^7$

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[3] Cf. Bamford and Dewar, *Proc. Roy. Soc.*, A, **192**, 309, 329 (1948); Faraday Society Discussion on the Labile Molecule (1947).

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Quantitative Paper Chromatography

Fisher, Parsons and Morrison[1] have shown experimentally that a linear relation holds between the area of the spot of test substance and the logarithm of the concentration at which it is originally applied. A theoretical derivation can now be given.

If it be supposed that the spot spreads by diffusion as it moves along the chromatogram, analogous equations developed in the theory of heat-flow may be applied. For a spot initially at concentration c_i over a circle of radius a, the appropriate equation[2] is:

$$c = \frac{c_i}{2Dt} \cdot \exp\left(\frac{-r^2}{4Dt}\right) \cdot \int_0^a \exp\left(\frac{-r'^2}{4Dt}\right) \times I_0\left(\frac{rr'}{2Dt}\right) \cdot r' \cdot dr',$$

where c is the concentration at radius r at time t, and D is a diffusion constant. Putting F for the integral containing the modified Bessel function, remembering that $r^2/4Dt$ equals $A/4\pi Dt$, where A is the area of the spot, and taking c as the concentration at the limit of visibility, that is, at the edge of the spot, we can take logarithms (to base 10) and rearrange equation 1 to become:

$$A = \frac{4\pi Dt}{\log e}\,[\log c_i - \log c - \log (2Dt) + \log F], \quad (2)$$

which only differs from the experimental relation found by Fisher *et al.* by the term log F; c and Dt are constant for the same substance in the same chromatogram.

Values of log F were computed graphically in the region of $2Dt$ from 0·02 to 1·50 sq. cm., a from 0·1 to 1·0 cm., and r from 0·1 to 2·0 cm. It was found that a further re-arrangement could be made so that direct use of the simple plotting of A against log c_i was possible. Log F increases as A increases. Replacing log F by $(k.A + B + f)$, where k is a proportionality factor, B is the value of log F when r is zero, and f is the deviation from proportionality, and noting that B equals $\log 2Dt + \log [1 - \exp(-a^2/4Dt)]$, we can write:

$$A = \frac{4\pi Dt}{\log e - 4\pi Dt\,.\,k}$$

$$\left[\log c_i - \log c + \log\left\{1 - \exp\left(\frac{-a^2}{4Dt}\right)\right\} + f\right]. \quad (3)$$

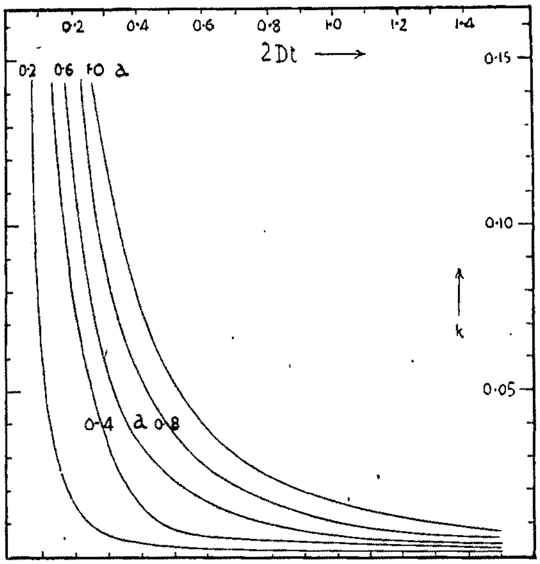
Values of k and f were computed by drawing a straight line to the plots of log F against A (up to A equals 7·0 sq. cm.), so that the maximum deviations positively and negatively were equal. The graph shows values of k. The table (from which the accuracy of the computations may be judged) shows the deviation calculated as a percentage; thus a percentage of 1·0 corresponds to the value 0·00432 (log 1·01) of f, and may be considered as equivalent to an error in the determination of c_i from the plot of A against log c_i.

Percentage deviation

		a (cm.)				
		0·2	0·4	0·6	0·8	1·0
$2Dt$ (sq. cm.)	1·50	0·1	0·4	0·5	0·4	0·3
	1·00	0·3	0·5	0·3	0·3	0·3
	0·75	0·6	0·1	0·3	0·6	0·6
	0·50	0·5	0·5	0·6	0·7	1·7
	0·40	1·2	1·2	1·0	1·9	3·3
	0·25	1·2	1·0	4·7	6·0	7·1
	0·10	6·0	15·0	23·0	7·5	—

The necessity of attaining the higher values of $2Dt$ in experimental work is clear, as is the importance of keeping the initial area of the spots small and uniform.

A practical example may now be considered. By measuring the areas of the spots in the diagrams of the communication of Fisher *et al.*[1] and relating them to the quoted length of 34 cm., the values of the arbitrary units of area may be estimated roughly, and the slope of their lines for the three amino-acids appears to be about 4 sq. cm. From equation 3, the slope S, that is, the factor outside the square brackets, gives $2Dt = 0{\cdot}0691\,.\,S/(1 + k\,.\,S)$. Thus, the value of $2Dt$ for their data cannot be greater than 0·28 (their a values are not given), and their expected error of 2 per cent in the determination of an unknown concentration (c_i) can be realized provided that the value of a is less than 0·4.



An obvious way of improving the accuracy is to run the chromatogram for a longer time, thereby increasing the magnitude of $2Dt$.

I am grateful to Mr. A. J. Ede for helpful criticism and advice.

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Location of Paper Chromatogram Spots of Purine and Pyrimidine Derivatives in Ultra-Violet Light

THE methods so far described in the literature for the identification of spots of purines, pyrimidines and their derivatives on paper chromatograms are unsatisfactory. We have found a simple and rapid method for their detection.

If the paper strip run with n-butanol as described by Hotchkiss[1] is examined in ultra-violet light transmitted by a Wood's glass or Corning 5970 filter (320–400 mμ) the spots are not visible, though the position of the butanol front is conspicuous as a fluorescent band. Light transmitted by a Corning 9863 filter (230–400 mμ), however, shows the spots as dark patches against the background of paper fluorescence, either by reflected or transmitted light. The most suitable light source was found to be a low-pressure mercury resonance lamp, and further experiments with various filters showed that the intensity in the region of the 254 mμ line was the important factor. The dark patches are probably due to the strong absorption of the radiation which excites the paper fluorescence; their boundaries are readily marked by a pencil so that they can be cut out and eluted for spectrophotometric estimation. The spots are visible down to concentrations of the order of 0·5–1·0 μgm./cm.[2].

The effect has been observed with adenine, adenosine, uracyl, uridine, thymine, cytidine, hypoxanthine, xanthine and various methylated xanthines.

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*Nor*adrenaline in Adrenal Medullary Tumours

BLASCHKO[1] has suggested the stages by which adrenaline can arise from tyrosine, the final stage being the N-methylation of the primary amine *nor*adrenaline. It is possible that this last stage occurs in the suprarenal medulla; but hitherto *nor*adrenaline has not been found in the normal suprarenal gland.

A portion of human suprarenal tumour was kindly sent to this laboratory by Dr. E. G. Hall. Histological examination by Dr. P. Glees showed that the tumour was a typical phæochromocytoma consisting of chromaffin tissue. An acid extract of the tumour was prepared and tested for adrenaline and *nor*adrenaline. The rat's uterus and the frog's perfused heart were used in order to determine the adrenaline content of the extract, since these preparations are insensitive to *nor*adrenaline[2]. It was found that 1 ml. extract was equivalent to 0·37 mgm. adrenaline.

When tested on the rabbit's duodenum and the spinal cat's blood pressure, which are approximately equally sensitive to adrenaline and *nor*adrenaline, the extract was found to be equivalent to 1 mgm. adrenaline per ml. The difference between the activities found on these two types of preparations may be assumed to be due to *nor*adrenaline. Thus 1 gm. tumour contained 3·7 mgm. *l*-adrenaline and 6·3 mgm. *l*-*nor*adrenaline. The presence of both amines was confirmed by tests with polyphenolase which were carried out by Dr. W. O. James. When the enzyme was incubated with tumour extract, a brown colour, typical of *nor*adrenaline, was produced during 10 min. This colour faded, and after 20 min. a rose-pink colour, typical of adrenaline, appeared. This reaction was also given by a mixture of the synthetic amines and is specific for them. James[3] has described a method of separating adrenaline and *nor*adrenaline by paper chromatography. Phenol is used as a solvent, and after 20 hours the positions of the two amines are determined by the pink colour produced by them when the paper is sprayed with potassium ferricyanide solution. The tumour extract gave two spots at positions typical of adrenaline and *nor*adrenaline.

Two other adrenal medullary tumours were also examined. One was sent by Dr. G. M. Wilson from St. Mary's Hospital; 1 gm. of this tumour was found to contain 5·3 mgm. *l*-*nor*adrenaline and 0·32 mgm. *l*-adrenaline. The other was sent by Dr. A. M. Joekes from the British Postgraduate Medical School, and 1 gm. contained 5·5 mgm. *l*-*nor*adrenaline and 0·37 mgm. *l*-adrenaline. These results were obtained from assays against both *l*-adrenaline and *dl*-*nor*adrenaline on the rat's uterus and rabbit's duodenum.

Since *nor*adrenaline has slightly greater pressor activity than adrenaline, it is probable that the attacks of high blood pressure caused by the tumours were mainly due to *nor*adrenaline.

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Gelatination of Blood Serum with Fibrinogen

WHILE much research work is focused on the complex mechanism of biological blood coagulation, comparatively little attention has been paid to the action of fibrinogen on blood serum. Whereas the action of the complete activator system leads with blood-plasma to a relatively firm coagel in a matter of seconds, the action of pure fibrinogen on blood serum leads to an elastic coagel only after two or three hours. This coagel remains transparent, and as there is no apparent sign of coagulation of fibrinogen, we prefer the term 'gelatination'.

The fibrinogen (human) was prepared after the method of Astrup and Darling[1] and was up to 96 per cent clottable. We measured the action on normal blood serum (human), on blood serum and plasma after treatment with barium sulphate (Rosenfield and Tuft[2]) and on a 5 per cent solution of albumin (crystalline, bovine). The mixtures with varying amounts of fibrinogen wore in small test tubes at 18° C. The volume in each case is 1·2 ml.

Fibrinogen added (mgm. per cent)	Serum (human)		Barium sulphate serum		Albumin 5 per cent	
	3 hr.	24 hr.	3 hr.	24 hr.	3 hr.	24 hr.
15	++	++	+	++	–	+
30	+++	+++	++	+++	–	++
60	+++	+++	++	+++	–	+++
120	++	+++	+	+++	–	+++
180	+	+++	+	+++	–	+++

+, Marked increase in viscosity; ++, partial gelatination; +++, tube can be reversed without spilling

When 120 mgm. per cent of fibrinogen is added, gelatination of serum is complete after two to three hours, in serum treated with barium sulphate after six hours and in 5 per cent albumin only after eighteen hours. It seems that serum globulins accelerate the process but are not absolutely necessary. No gelatination takes place in oxalated blood plasma after threefold Seitz-filtration (Owren)[3] or after treatment with barium sulphate.

In order to discover the influence of nucleic acids on gelatination, serum solutions of yeast nucleic acid[4] ($C_{38}H_{49}O_{29}N_{15}P_4$), adenosine-3-phosphoric acid ($C_{10}H_{14}N_5O_7P + H_2O$), adenosine triphosphate ($C_{10}H_{12}O_{13}P_3Na_4$) and thymonucleic acid with a molecular weight of approximately a million were tested in two series: (*a*) concentration of fibrinogen 30 mgm. per cent, and of nucleic acids 917 mgm. per cent; (*b*) 120 and 666 mgm. per cent respectively.

Series	Yeast nucleic acid			Adenosine-3-phosphoric acid			Adenosine triphosphate			Thymonucleic acid		
	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.
a	+	++	++	–	–	–	–	+	+	+	+	++
b	+++	+++	+++	–	–	–	–	+	++	++	++	+++

It follows that yeast nucleic acid as well as thymonucleic acid only slow down the process of gelatination, whereas adenosine-3-phosphoric acid inhibits it. With this latter substance the clotting time of fibrinogen by thrombin is twenty times as long as with yeast nucleic acid[4].

The adenosine-3-phosphoric acid was provided by Messrs. Hoffmann–La Roche and Co., Basle.

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Action of 'Blood-Group Substances' on the Anti-Ken Serum

SINCE the publication of our previous communication[1], we have continued our investigations with the anti-Ken serum, but after adding Witebsky's 'purified blood-group substances', supplied by the courtesy of Sharp and Dohme, Philadelphia.

Testing 248 unselected bloods with the original serum gave the following results[1]:

	+	−
A cells	46	45
O cells	102	55

Testing 300 unselected bloods with the 'absorbed anti-Ken' serum gave a different distribution:

	+	−
A cells	77	73
O cells	76	74

We do not find in our new series tested with the 'absorbed' serum the difference observed previously when using the original serum; but, on the contrary, there is an even ratio of about 50 per cent + and 50 per cent − reactions in both *O*- and *A*-groups. This ratio was actually the one found in the *A*-cell group when using the original serum.

Thus the addition of 'blood-group substances' seems to inhibit the constituent of the original serum responsible for the agglutination of some 15 per cent of extra-bloods in the *O* cell group. This indicates that the original serum contains two antibodies.

Unfortunately, our stock of the original anti-Ken had come to an end when we realized this fact. The patient was bled, but the agglutinin(s) had disappeared from her serum. We are now attempting to get an immune reaction by inoculating her with small amounts of Ken + blood.

Priority in the recognition of the phenomenon we have described should go to R. R. Race[2], when absorbing Andresen's[3] anti-L_2 with the *A* blood-group substance prepared by W. T. J. Morgan. There is, indeed, a close similarity between L_2 and Ken: the positive and negative reactions of anti-L_2 and anti-Ken are distributed similarly with a difference between *O*- and *A*-cell groups; on the other hand, both sera behave in the same way when in contact with 'blood-group substances'.

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Nov. 17.

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[1] Hubinont, P. O., *Nature*, **162**, 457 (1948).

[2] Race, R. R. (personal communication).

[3] Andresen, P. H., *Acta Path.* (in the press).

'Brassy' Eosinophilic Granulocytes and their Possible Role in Iron Transport

IN blood films stained by one of the Romanowsky modifications, the granules of the eosinophiles are ordinarily scarlet. Occasionally, however, they exhibit a range of colour modification which varies from brownish-red, through grey to almost coal-black. The latter granules are not to be confused with those of the basophilic granulocyte, which have also been found in otherwise unaltered 'eosinophiles' in autochthonous hyperheparinæmias; truly basophilic granules are metachromatic when stained with toluidine blue, while the dark granules of the 'brassy' eosinophiles (as such cells have come to be termed in laboratory parlance) are not basophilic nor do they stain with toluidine blue. The appearance of the 'brassy' granule does not seem to be a staining artefact, as they appear preponderantly in the blood films of certain individuals even though these blood films have been subjected to identical and concurrent staining procedure with films exhibiting the scarlet eosinophilic granule.

The probable nature of the 'brassy' granule was disclosed inadvertently in another connexion. A patient with megaloblastic anæmia was given parenteral liver extract therapy and made a good response with the usual reticulocytosis, increase in blood cholinesterase and eosinophilia, but the anæmia shifted to a hypochromic type. The latter phase was then treated with ferrous lactobionate solution given intravenously. On one occasion, when it was desired to make a routine blood study (to save the patient an additional venipuncture), blood was aspirated directly into the syringe from which the iron solution had just been expressed. The smear from this blood showed all eosinophiles to be of the 'brassy' type. The addition of small quantities of ferrous salts to blood samples was found to convert the ordinary eosinophilic granule to the 'brassy' form. That this form may represent an iron conjugate of the eosinophilic granule is a possibility that might open the additional possibility that the eosinophile is concerned in some phase of iron transport.

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Aug. 14.

Amino-Acid Constitution of Diphtheria Toxin and Toxoid

WHILE examining by two-dimensional paper partition chromatography the acid hydrolysates of highly purified diphtheria toxin and toxoid, preparatory to attempting the quantitative estimation of the constituent amino-acids by the method of Woiwod[1,2], a striking qualitative difference has been observed between the chromatograms of these two substances, which we feel may be significant.

The photograph of a typical chromatogram of the hydrolysate of toxin is given in Fig. 1, while that of toxoid is shown in Fig. 2. It will be seen that tyrosine is present in the toxin but not in the toxoid hydrolysate. No other major differences have been observed between the chromatograms.

The highly purified diphtheria toxin and toxoid used in this work were prepared by the method of Pope and Linggood (unpublished), and both preparations contained 2,100–2,200 Lfs./mgm. protein nitro-

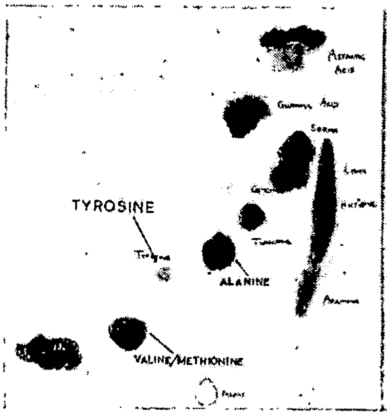

Fig. 1

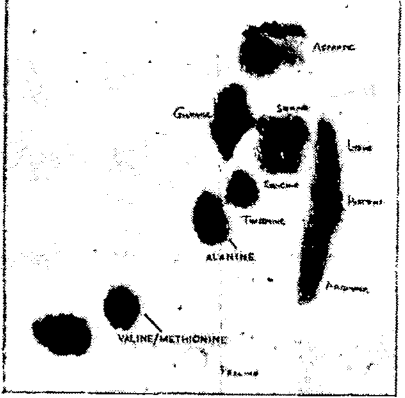

Fig. 2

gen, but were somewhat less pure in terms of Lfs./mgm. total nitrogen. The non-protein nitrogen was eliminated from both preparations by precipitation and washing with trichloroacetic acid (5 per cent) prior to hydrolysis of the protein with 6*N* hydrochloric acid for 72 hours.

Samples of the hydrolysates containing approximately 200 µgm. of nitrogen were used for the preparation of the two-dimensional chromatograms, which were run first with *n*-butanol-acetic acid and then with phenol.

Holden and Freeman[3], and also Brown[4], have shown that formaldehyde reacts with tyrosine under alkaline conditions to give a product stable to acid hydrolysis, devoid of amino-nitrogen and negative to the ninhydrin test. Therefore, a possible explanation of our observations is that the amino-group in the tyrosine present in diphtheria toxin is not involved in a peptide linkage, but is free to combine with formaldehyde during the process of 'toxoiding'. This is not, however, the only explanation for the apparent lack of tyrosine in the hydrolysed toxoid, and we are engaged in further work to find the actual mechanism involved. This will be published in detail later.

A. J. Woiwod
F. V. Linggood

Wellcome Research Laboratories,
Beckenham, Kent. Nov. 24.

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[1] Woiwod, A. J., *Nature*, 161, 169 (1948).

[2] Woiwod, A. J., *Biochem. J.*, 42, xxviii (1948).

[3] Holden, H. F., and Freeman, M., *Aust. J. Exp. Biol. Med. Sci.*, 8, 189 (1931).

[4] Brown, A. E., *J. Amer. Chem. Soc.*, 68, 1011 (1946).

Microbiological Oxidation of Sterols

In an earlier communication[1] we stated that by cultivating *Proactinomyces roseus* in a synthetic culture medium in which the only source of carbon and nitrogen was 2 per mille pyridine, and using up the superfluous nitrogen by emulsifying 0·1 per cent cholesterol in the medium and aerating it at 34° C., in two weeks we obtained 7-oxycholesterol and 4,5-cholestenone. Later, we received a letter from Dr. G. A. D. Haslewood, of the Physiological Laboratory, Guy's Hospital, London, S.E., expressing doubt that the occurrence of 7-oxycholesterol was the result of the microbiological oxidation; in his opinion, the result was analogous to the production of 7-oxycholesterol from cholesterol in alkali medium, by aeration and elevated temperature, as shown by Bergström and Wintersteiner[2,3], in which case the micro-organism plays no part.

We have now carried out further experiments. In a synthetic culture medium at *p*H 7, *Proactinomyces* previously cultivated in a 2 per mille pyridine solution decomposes the pyridine into ammonia at 34° C. without special aeration, besides incorporating part of the nitrogen into itself. After complete destruction of the pyridine, the *p*H of the culture rises to 7·5. We then add 0·1 per cent cholesterol to the culture and again 2 per mille pyridine. At the same time we begin aeration at 34° C. Two weeks before extraction of the substances, we determined the *p*H of the cultures and found the average value to be 8·2–8·4.

Control experiments were carried out by regulating the same synthetic pyridine culture medium with ammonia to the minimum *p*H of 7·5 in one control, and in the other to the maximum *p*H value obtained at the end of the culture, that is, 8·2–8·4, and, on adding cholesterol, aerated it under the same conditions as in our chief experiment. In the control experiments we never obtained 7-oxycholesterol at these *p*H values. In a special series of experiments without micro-organisms in the synthetic pyridine culture medium described we found that, with aeration at 34° C., we obtained 7-oxycholesterol only at the outside values of 11–11·5 *p*H, and then only traces.

We must, therefore, repeat that, in the experiments originally reported[1], the 7-oxycholesterol was produced as an effect of the activity of the micro-organism.

A. Krámli
J. Horváth

Hungarian Biological Research Institute,
Tihany. Nov. 22.

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[1] Krámli, A., and Horváth, J., *Nature*, 162, 619 (1948).

[2] Bergström, S., and Wintersteiner, O., *J. Biol. Chem.*, 141, 597 (1941); 143, 503 (1942); 145, 309, 327 (1942).

[3] Haslewood, G. A. D., *Nature*, 154, 29 (1944).

Complement Fixation Test in Contagious Ecthyma

During both research and routine complement fixation tests with foot-and-mouth disease virus, we attempted to develop a similar test for the condition known as contagious ecthyma of the lips, infectious or contagious pustular dermatitis or stomatitis and infectious labial dermatitis. The observations clearly indicate that this condition has an extensive geographical distribution.

The technique used was similar to that described by Aramburu[1] for complement fixation test in foot-and-mouth disease. The antigen was made from desiccated crusts from sheep infected experimentally with the virus. The scabs were thoroughly triturated with sand, suspended in 1 in 10 saline and centrifuged 10 min. at 2,500 r.p.m.; the supernatant fluid, containing the antigen, could be preserved for at least fifteen days at – 20° C. Sera were obtained both thirty-one and eight days after infection, centrifuged 15 min. at 3,000 r.p.m. and inactivated 45 min. at ~ 56° C. In our experiments the control tubes included the three types of foot-and-mouth disease sera, guinea pig normal serum, and both ovine and human normal serum.

Although only eighteen tests were made, all gave positive results, thus demonstrating both the specificity of the test in this condition and the appearance of complement-fixing antibodies in sheep serum. A typical result (Protocol No. 270) is given herewith.

Tube	Antigen	Serum	Saline	Complement	Red cells	Minutes reading		
						10	20	30
1	0·25	0·05	0·25	0·25	0·5	++++	++++	++++
2	0·25	0·05	0·25	0·25	0·5	++++	++++	++++
3	0·25	0·05	0·25	0·25	0·5	++++	++++	++++

Further experiments with regard to its specificity will be published in due course.

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Instituto Nacional de la Fiebre Aftosa,
Buenos Aires.
May 20.

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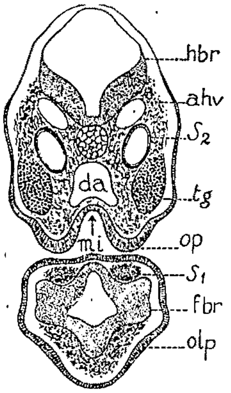
[1] Aramburu, H. G., *Rev. Soc. Med. Vet. Bs. As.* (Julio-Septiembre, 1947).

The 'Oral Placode' in Certain Selachii and its Bearing on the Origin of the Vertebrate Mouth

IN the course of a study of the early development of the sensory placodes of the head region in some cartilaginous fishes from the Red Sea, namely, *Carcharinus melanopterus* (Quoy and Gaimard), *Rhynchobatus djiddensis* (Bloch and Scheider) and *Rhinobatus halaui* (Müller and Henle), it was found that in the embryos of length 5–10 mm., the epidermis is generally thickened on either side of the roof of the mouth invagination and in the neighbourhood of the hypophysis (see drawing). This ectodermal thickening is of the same structure as the epibranchial placodes which, in these embryonic stages, are situated at the dorsal edges of the corresponding branchial slits. In view of its particular situation over the mouth, it should be regarded as homonymous with these epibranchial placodes and as belonging to them. The structure in question should then have the same relation with the oral slit as the epibranchial placodes have with the spiracle and the following gill-slits. The term 'oral placode' was suggested for this structure, which is thus interpreted as providing an interesting confirmation and adding further evidence to Dohrn's[1] well-known and much discussed[2] theory considering the mouth of vertebrates as derived from a pair of anterior coalesced gill-slits.



Transverse section through the mouth region of a 9·5-mm. embryo of *Rhynchobatus djiddensis* illustrating the relation of the oral placode and the mouth

ahv, anterior head vein; *da*, dorsal aorta; *fbr*, fore-brain; *hbr*, hind-brain; *mi*, mouth invagination; *olp*, olfactory placode; S_1, first head somite (Platts' mass); S_2, second head somite; *tg*, trigeminal ganglion

Details of this work will be published elsewhere.

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[1] Dohrn, A., "Der Ursprung der Wirbeltiera u. des Prinzip des Funkionswechsels" (Leipzig, 1875).

[2] Naef, A., *Pub. Staz. Zool. Napoli*, 7, No. 12 (1925).

Shadow Area of Convex Bodies

VOUK[1], in a letter in *Nature*, gave a proof of Cauchy's theorem that the average area of projection of a convex body on a plane equals one-quarter the surface area of the body. The following less formal version of the proof may appeal more to non-mathematicians.

The projected area of a sphere equals the area of a circle of the same radius, that is, $\pi \times (\text{radius})^2$. The surface area is $4\pi \times (\text{radius})^2$. Hence, Cauchy's result is true for a sphere. Because of the symmetry of a sphere, the result must be true of each infinitesimal element of the sphere's surface, that is, any infinitesimal element of area considered in all its possible orientations has an average projected area equal to one quarter of its own area. Now the surface of any convex body consists of a number of such infinitesimal areas; hence by adding the separate contributions from each we obtain Cauchy's theorem. As pointed out by Vouk[1], if the assumption of convexity were not made, the above value of shadow area will be too large, because the contributions of certain surface elements in certain orientations will be nullified by obscuration.

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Vouk, V., *Nature*, 162, 331 (1948).

Bilateral Asymmetry shown by the Metachronal Waves in Protochordate Gill Slits

BECAUSE of delay in correcting and returning proofs, the letter under this title in *Nature* of January 22, p. 137, contains an error in the last paragraph. The larvæ of Enteropneusta rotate in an anti-clockwise direction viewed from the animal pole, *not* a clockwise one. To judge from the literature there cited and from a later reference to the subject by van Wijhe[1], the hatching larvæ of *Amphioxus*[2], which are remarkably similar in general appearance to *Saccoglossus* larvæ, rotate consistently in the same direction and swim in a similar manner.

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Ministry of Agriculture and Fisheries,
Burnham-on-Crouch, Essex.
Jan. 24.

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[1] Wijhe, J. W. van, *Proc. Akad. van Wetensch.*, Sect. Sci., **30** (2), 991 (1927).

[2] Hatschek, B., *Arb. Zool. Univ. Wien*, **4**, 1 (1881).

PROBLEMS OF OLD AGE

THE medical, social and economic problems created by a rapidly ageing population were the subject of a symposium presented before a joint session of Sections I (Physiology) and J (Psychology) at the British Association meeting at Brighton on Friday, September 10, 1948.

The subject was introduced by Sir Ernest Rock Carling, who reminded his audience that the great majority of the elderly are healthy and independent —they outnumber the ailing and decrepit by more than 30 to 1—and for them the most pressing problem is how to maintain to the end of their days the standard of living of their working life. The time has come for the elderly to revolt against the convention, based on sociological, not biological, grounds, that there is a fixed retirement-age beyond which they are unfit for further work. It is a truism that chronological age is no guide to capacity in the individual; but what we want to know is, how far the increased expectation of life in the last fifty years has extended working-capacity. Although at sixty to-day we have only a matter of months more to expect than those of that age fifty years ago, nevertheless a far greater number are reaching the sixth and seventh decades, presumably because they have been less subject in early and middle life to diseases which have come largely under control.

Ageing begins at birth, and an athlete is 'old' at thirty-five. Yet what is 'old'? There have been few controlled researches into the causes or processes of ageing. Over the whole range of function we need the help of physiologists to measure such modification as age brings. In war they extended the functional powers of young men to a remarkable extent; by similar study they will certainly be able to suggest optimum conditions for maximum accomplishment when functions are modified or restricted by age. Just as in war combat-stress had to be allowed for, so in peace the stresses inherent in the job may be too great to be easily borne as the years pass: adaptations of work for the elderly must extend to psychological as well as physical demands.

Recent work among the derelict 'chronic sick' has shown remarkable recuperative powers among those thought to be past remedial treatment. If such efforts can restore lost powers, those powers should never have been lost; and continuance in some occupation should be, and is, a sound recommendation for the prolongation of life and happiness. Given some inducement and suitable conditions, the country can draw upon a proportion of the elderly for productive work. For the young disabled there exist workshops where, with special appliances, and adaptations of machines—and a deal of encouragement—selected jobs are accomplished.

Laziness, Sir Ernest maintained, is at the bottom of much facile acceptance of 'too old at forty, fifty, or sixty'. If the Civil servant must retire, why does not the clergyman? If the barrister ceases to practise, why not the judge?

The small percentage of the elderly whose health or social circumstances deteriorate have been in the past scurvily treated. For them the 'institution' must be replaced by small homes, graded to suit the phases of ageing and grouped to enable the residents to pass from semi-independence to full communal care without too much apparent change in surroundings. If local authorities and voluntary bodies co-operate—as they can under the National Assistance Act—it should be possible to throw off the damning inheritance of the 'workhouse' stigma that hangs about public endeavour and the 'charity' that, at least in the prejudices of some local politicians, taints private ventures. Though the proportion of old people badly needing such help may be small, the task of providing for them is enormous, for some two or three thousand homes are needed.

Dr. Marjory Warren followed with a description of her own pioneer geriatric unit at the West Middlesex County Hospital. She maintained that the tendency to lay emphasis on *cure* rather than *care* may be in part responsible for the lack of interest and industry with the so-called incurables. More than 80 per cent of the old people admitted to hospital are suffering from pathological, physiological or psychological conditions which fall under two headings, medical and social. The medical conditions are: degenerative arterial disease, degenerative heart disease, arthritis, malignant diseases, and progressive neurological diseases. The social conditions are lack of hygiene, help, food and company. A service of gerontology is needed which will integrate medical and social care. In addition to domestic and social care, such a service requires three types of accommodation: a geriatric unit based on a general hospital, a long-stay annexe for the truly irremediable, and hostels of various kinds for those reasonably fit who have no suitable home of their own. Medically, all three should be under the same supervision, because the lines between sickness and infirmity, and infirmity and health, become finer as years advance. Yet new legislation now divides the authorities for medical treatment and social care of the elderly.

Dr. Warren described the present position as chaotic and uneconomic. A very large number of remediable old people lie at home under inadequate care and no treatment, unable to get a bed in hospital. In hospitals there are elderly ambulant patients, no longer needing hospital care, for whom no hostel vacancies exist; and in hostels will be found sick old people without access to treatment.

The present writer attempted to set the old-age problem in the context of the larger problem of European population trends, which have social, economic and strategic implications for Western civilization. The population of Europe, having grown enormously—and in relation to world population—in the last three hundred years, has now reached maturity and faces relative decline. To-day it is the non-European populations that are growing fast, with declining death-rates and high birth-rates. North-western Europe—headed by France, once the most populous and now the most 'aged' nation—has led the process, and is destined to contract relatively to eastern Europe, and in particular to the U.S.S.R. Russia, because of late development, is relatively young; and this has a possible strategic significance. It has been estimated that, if present trends continue, another twenty or twenty-five years will see a decrease of nearly 5,000,000 in the man-power of military age in Europe west of U.S.S.R., and, an increase of more than 13,000,000 in Russia's military man-power. There is a shift in the balance of man-power from west to east.

The static, perhaps soon declining, populations of western Europe are ageing populations, and their working populations are ageing and declining. This means that for youngsters it is easier to start work, but harder to advance, since there are fewer opportunities at the top. The difficulty of individual advancement encourages solidarity among workers, accompanied by growing pressure in favour of early retirement—blindly regardless of the fact that the retired have to be maintained from the product of the reduced labour force. The increasing social burden substitutes group responsibility for individual or family responsibility, and the enterprising initiative of an expanding economy is replaced by a longing for the security of an ordered economy. Thus there is created the 'problem of old age'.

In the United Kingdom the present percentage of old people in the population is double what it was in 1901, and treble what it was in 1881—just a life-time ago. It will go on increasing until, in the life-time of many now living, old people will equal or outnumber the children, and the total proportion of dependants (children and old people) to workers will increase from the present 54 per cent to 62 per cent. Only technological progress and increasing productivity will be able to keep pace with this growing social burden.

If the prospect for Britain, and Europe, appears gloomy—with our dwindling man-power and the growing predominance of other cultures—we have to remember that it was Western civilization which, in its vigorous youth, showed the world how to overcome poverty, famine and disease, and so how to release the brake upon population growth. It has yet to be proved that there is any compulsory connexion between social and animal biology, or that an ageing population means a senile body politic.

Mr. A. T. Welford described the tentative results of some experiments, in the Psychological Laboratory at Cambridge, in measuring the achievement of different age-groups at realistic and fairly complex tasks involving motor and mental skill. The first task—throwing chains at a target, first direct, then over a bar, and then with target screened and seen only in a mirror—revealed little difference in accuracy from the 'teens to the sixties until the target was screened, when accuracy fell steadily with age (and the over-thirties tended to look for the chains to throw while the youngsters kept their eyes on the mirror). In the second task the subjects were required to move a pointer on a piece of graph-paper until it corresponded with a small stationary ball on another piece alongside; if successful, the ball had to be started moving and then to be stopped in a new position, and the cycle began again. At this task there was a slightly better total achievement by the under-thirties; but the older subjects' much slower, more deliberate, and also more accurate performance might in a sense be judged more efficient.

In mental skills two experiments were described which required the comprehension and organisation of data. First, in drawing conclusions from a set of logically connected statements, older people tended to treat the statements as real, and to talk about them rather than deduce from them. In the second 'mental' experiment the subjects were required to deduce, by meter-readings, the correspondence between a circuit-diagram and a box with terminals connected underneath by resistances. Here the older age-groups needed to take more readings, some more than once, which indicates their greater difficulty in organising the data and perhaps the beginnings of a loss of short-term memory. In conclusion, Mr. Welford stressed the tentativeness of all these interpretations, but suggested that an important locus of change with age lay in the manner of organising data or comprehending a display.

Mrs. Barbara Lewis dealt with one aspect of the economic consequences of an ageing population, namely, the employment of older workers. Since such employment may become an economic necessity, it needs to be examined from both the old people's and the employers' points of view. Are old people willing to work, and is their work economic? Like all recent investigators, Mrs. Lewis was able to confirm, from her Birmingham survey of the over-seventies, the therapeutic value of continued occupation: that women live longer than men is undoubtedly influenced by men's tendency to retire with a jolt at a fixed age, while women suffer no such sharp break. Though some men look forward to freedom to pursue hobbies and interests, there is a difference between the social and occupational groups: clerks and managers usually relish the prospect of retirement but are deterred by the certainty of a much lower standard of living, whereas manual workers frequently complain of boredom in the retirement into which they have been tempted by the smaller gap between earnings and pension.

The old people available and able for employment fall into three groups: those preferring and intending to work as long as possible; those failing or tired, who look forward to ceasing work as soon as they are financially able to retire; and those less definite about retirement, who could be swayed by a pension scheme offering greater inducements (than does the National Insurance Act, 1946) to postpone retirement or by special conditions of work if they continue.

From the employers' point of view, it is generally only when loss of efficiency and the need for transference to lighter work arises that there is formal consideration of an employee's age and capacity. (On the staff side it is different, and strictly enforced retiring-ages are common, to preserve reasonable prospects of promotion.) There is no difficulty about retaining skilled craftsmen, even when pace and output fall off; but the unskilled or semi-skilled factory worker, who may, especially in heavy trades, lose efficiency with increasing years, is not so easy to retain, since alternative lighter work may be difficult or impossible to arrange. Even where old men could successfully undertake work normally done by women or boys, the trade unions' insistence on the minimum adult man's rate makes old men too expensive to use. Even if two old men could be paid only half a younger man's rate to reach the younger man's output, the costs of production will still be higher, since the administrative costs per worker have to be taken into account. On the other hand, older workers have many recommendations: they are normally more conscientious and better time-keepers, have greater respect for rules and the employer's property, and generally mind their jobs more carefully, knowing that other work will be hard to find.

As a consequence of an ageing population, industry will have to adjust itself to a labour force with a higher proportion of older workers. This may involve more mechanization and the further elimination of heavy exertion, possibly some special conditions for elderly workers, and certainly a considerable amount of research and job-analysis to reveal the types of work most suited to the employment of older workers. Mrs. Lewis concluded the symposium with the cheerful reflexion that, in encouraging old people to remain as long as possible in employment, the best interests of the nation and the aged coincide.

In the discussion that followed, it was clear that some lay members of the public, at least, are more interested in the causes of ageing and in the search for some partial elixir of life than in the more serious problems raised for society by a rapidly ageing population. W. A. SANDERSON

NEW BUILDING MATERIALS

THE widespread incidence of the shortage of houses justifies even a belated account of a discussion on "Building Materials with Special Reference to New Materials", held in Section B (Chemistry) of the British Association on September 14. The full text of the four main papers read at the discussion has already been published*.

Speaking on "Some Modern Trends in Building Materials", Dr. F. M. Lea, director of building research, Department of Scientific and Industrial Research, described the factors which influence both the development of new materials and new methods and their assimilation into the traditional structure of the building industry—developments which have made it essential to study building scientifically with the object of reshaping its traditions to modern needs. The potential demand for building materials is so large that the industry offers an attractive field for exploitation of newly discovered materials and a prospective outlet for industrial by-products. To be successful, a new material must be suitable in all needful respects for the purpose for which it is intended, and must be capable of being used without major change in existing craft processes. Large manufacturing resources and ample supplies of raw materials are essential if a new product is to become generally used. The industry can readily absorb new materials introduced on a relatively small scale, and these, if they prove to meet a real need, can be commercially successful and lead to the establishment of major industries, as has happened, for example, with asbestos-cement products, concrete roofing-tiles and fibre boards. Increased stress on functional requirements—thermal insulation, sound insulation and so on—leads to consideration of how the technical needs can be met by materials singly or in combination with others. This stimulates the development of new materials or new ways of using them. Changes must of necessity be slow because new materials and new techniques have to be grafted on to an established body of practice by a widely scattered labour force.

Dealing with "The Use of Aluminium Alloys in Building", Mr. E. I. Brimelow, of the Chief Scientific Adviser's Division, Ministry of Works, described the rapid growth of the aluminium industry which has brought aluminium and its alloys to the status of engineering materials in little more than a century. The strength of aluminium alloys compares favourably with that of mild steel; the lower modulus of elasticity can be allowed for by appropriate increase in the dimensions of structural members without undue increase in weight. The relatively low melting point need cause no anxiety about the fire-resistance of loaded members; it is necessary only to provide a thicker covering for insulation and fire protection to obtain a performance comparable with that of steel. The low density of aluminium and its versatility of form fit it for use as a decorative material, as window-frames and rain-water goods, and, with due discrimination, for plumbing. It is used for spray coatings and as scaffolding. The low emissivity of clean, bright aluminium foil allows it to be used in cavity types of construction as an insulating material. Though generally resistant to corrosion, some precautions are necessary in the use and maintenance of aluminium and its alloys. Anodizing affords useful protection and gives a good surface for painting, which is recommended for rain-water goods in industrial and coastal districts. The good appearance of aluminium window-frames can be maintained by regular washing with water or by polishing with wax. In plumbing applications, electrolytic corrosion can be avoided by appropriate choice of the associated materials and by use of insulating washers. Use of aluminium for hot- and cold-water supply installations will not be advisable until the cause of a pitting type of corrosion which occurs in some districts has been further studied. The aluminium bungalow, using aluminium in combination with foamed-concrete insulation, has made a substantial contribution to the temporary-housing programme. With some improvements, the method of construction is being extended to provide permanent houses, schools and factories. Shortage of building materials has given opportunity for trial of those new uses for aluminium which could be technically justified, and the experience so gained will be a valuable guide for the future. The advent of cheaper methods of production would increase its potentialities.

Dr. T. W. Parker, of the Building Research Station, dealt with "Light-weight Building Materials", development of which has been fostered by present demands for thermal efficiency arising from the desire to achieve economy in fuel consumption and to provide increased comfort for the occupants. Low-density blocks can be used as load-bearing materials; sheet materials form linings or cladding; fibrous or granular materials are used as 'loose fill' or as blankets or 'bats'. Light-weight blocks, besides having a substantial insulating value, have the merit of high thermal capacity, the importance of which is often overlooked. Its influence in smoothing out variations in temperature is particularly valuable where intermittent methods of heating are installed. The greatest advance among low-density materials has been in the development of cellular concrete, which can be made in a number of different ways with a density of 20 lb. per cu. ft. upwards. Except in the aluminium bungalow, this material has not yet been used to any great extent in Great Britain, but experience in Sweden has demonstrated its potentialities. Light-weight sheets used as wall linings provide thermal insulation and offer a surface that can be quickly warmed to a comfortable temperature. Such materials must be robust enough to withstand accidental damage. They must not introduce an additional fire hazard. When circumstances preclude the use of low-density boards, the desired thermal resistance can be attained by using stronger boards fixed with an air space behind them. 'Loose fills', blankets and 'bats' form a convenient form of insulation for hollow walls and for roofs and ceilings. They must be chemically and physically stable, and should not give off noxious or combustible gases in the event of fire. They are mostly made from glass-wool, slag-wool or mineral-wool. Production of vermiculite in South Africa has stimulated interest in expanded vermiculite for use as 'loose fill', as concrete aggregate, and as a constituent of insulating plaster applied by spraying. Its cost is at present higher than that of other forms of insulation.

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* *The Builder*, 175, 335, 365, 393, 454 (1948).

Speaking on "The Use of Plastics in Building", Mr. R. J. Schaffer, of the Building Research Station, stressed the importance of selecting the building (and all other) applications of plastics with due regard to their suitability for the purpose intended. The idea of using plastics, other than resin-bonded wood, as load-bearing members is no longer of practical interest. Thermoplastics are obviously unsuitable for such use; the low modulus of elasticity, lack of ductility and high cost make it impracticable to use thermo-setting plastics. The advent of synthetic, waterproof glues has increased the potentialities of plywood and of glued construction in timber, and has led to the development of new kinds of building-board made from wood-waste or other by-products. Plastics enter into the composition of a variety of flooring materials. Polyethylene, already used for piping beer, etc., promises to be useful for domestic cold-water supply and sanitary installations. Foamed or 'expanded' plastics may be used for thermal insulation. There is a wide scope for the use of moulded plastics as building fittings; adoption of the British Standards Institution certification mark will ensure that high standards of design and workmanship are maintained. R. J. SCHAFFER

THE NUFFIELD FOUNDATION

THE third report of the trustees of the Nuffield Foundation*, which includes a list of 'fellows' appointed during the year, the balance sheet and a schedule of grants, records an allocation of grants during the year ended March 31, 1948, amounting to £495,350, the largest of any year up to date. The grants allocated since 1943 now total £2,135,980; this includes £605,850 to medical sciences; £242,000 to natural sciences; £142,000 to social sciences; £509,900 (including £225,000 over fifteen years to the Dominion Students' Hall Trust for the development of London House) for fellowships and scholarships; and £589,700 (of which £500,000 is to the National Corporation for the Care of Old People) for the care and comfort of the aged poor. During 1947, the resources of the Trust have been enriched by a gift of £450,000 from Capt. Oliver Bird. This benefaction, to be known as the Oliver Bird Fund, is to be held on trust for promoting research into the prevention and cure of rheumatism or, failing that, for the advancement of health and relief of other sickness. The trustees are now turning their attention to the planning of the programme for the next quinquennium, and they point out that the welcome increase of State support for learning and research does not lessen the need for voluntary enterprise or decrease the importance of alternative sources of support if the principle—fundamental to a free and democratic society—is to be upheld that "there should be room for more than one opinion and for more than one means of putting that opinion to the test".

A new grant in the medical sciences of £50,000, payable as required over ten years, goes towards the capital and maintenance costs of a hæmatological research unit to be set up by the Medical School of the University of Oxford, in conjunction with the Nuffield Department of Clinical Medicine under Prof. L. J. Witts, and the Radcliffe Infirmary Department of Pathology under Dr. A. H. Robb-Smith. A second new grant of £4,000 has been made towards the expenses of a new inquiry into the relation of infant mortality and morbidity to environment for the whole of Great Britain. This inquiry is to be undertaken by the joint committee of the Royal College of Obstetricians and Gynæcologists and the Population Investigation Committee, with help from the Institute of Child Health of the University of London. Like the inquiry into the maternity services, begun in 1945, it will also require the help of the medical officers of health and health visitors. Progress has also been made during the year in building up a comprehensive rheumatism service under the Medical School, University of Manchester; in addition to clinical work in Manchester and Preston, an experimental clinic is being established at Walkden for the diagnosis and treatment of rheumatism in coal-miners, and an investigation commenced into the role of the oral septic focus in chronic rheumatism. The five-year study of student health at the Institute of Social Medicine, Oxford, commenced in January 1947, and as a result of a conference on student health at the Institute in July 1947, student-health services which are starting at other universities will be co-ordinated with the Oxford service to achieve comparable records and statistics. The first year's work under Prof. J. Z. Young in the Department of Anatomy, University College, London, on the mechanism of learning in various animals has confirmed the hope that study of the structure of the brain and the learning powers of cephalopods (and especially the octopus) will throw light on the nature of the learning process.

New grants in the natural sciences during the year have been for a scientific study of the principles that should guide agricultural policy in Britain, and £18,000 over five years to the University of Bristol for research under Dr. C. R. Burch on the improvement of the reflecting microscope and for an attempt to solve the problems involved in the manufacture of the microscope by machinery. The agricultural study is being conducted by Mr. T. E. Eastwood, under the guidance of a committee of which Sir William Goodenough is chairman. At the University of Birmingham progress is reported in work under Prof. M. L. Oliphant upon the design and creation of new equipment for further fundamental studies in nuclear physics. An additional research fellow has been appointed to the staff working under Prof. P. I. Dee at Glasgow, and in addition to successful work with the million-volt generator and thirty-million-volt synchotron, results of fundamental interest have been obtained in the development of 'detection' techniques for use with these machines. In the biomolecular research laboratory at Birkbeck College, London, under Prof. J. D. Bernal, the X-ray analysis group is studying crystalline proteins and viruses, as well as simpler and related organic compounds which might provide clues to the structure of the proteins themselves. Dr. S. Levine's extensive theoretical work has shown that long-range forces between colloidal particles can originate in the electrical double layers at the surfaces of the particles. Results obtained in cosmic-ray research under Prof. P. M. S. Blackett at the University of Manchester have already been described in *Nature* (**160**, 855; 1947), and a cloud chamber is now operating at the Jungfraujoch Laboratory, Switzerland, for further study of these new particles. Measurements of extensive showers with a very elaborate hodoscope are being started, and fundamental work on temperature and meteorological effects of cosmic rays is continuing.

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* Nuffield Foundation. Report of the Trustees for the Year ending 31 March, 1948. Pp. 92. (12–13 Mecklenburgh Square, London, W.C.1.)

Six research fellows are now working at the Clarendon Laboratory, Oxford, under Lord Cherwell, and the low-temperature department of the Laboratory has now been built up again; while in the small chemical laboratory of the Laboratory the use of chemical methods as an aid to exact methods in nuclear physics is being developed. At the Cavendish Laboratory, Cambridge, Dr. E. Orowan's group of research workers has developed a theory of low-temperature creep in metals and a photo-elastic method of recording the distribution of roll-pressure over the area of contact, and have investigated a new mechanism of recrystallization in cold-worked metals. In the investigation at the University of Cambridge into the mechanical properties of soil, the study of soil dynamics has centred largely on the improvement of the oscillograph apparatus for the simultaneous recording of the component soil forces on the tillage implement. A theory of the relation between the permeability of a structured material such as soil and its pore-size distribution has been checked by observation on the permeability over a wide range of moisture contents.

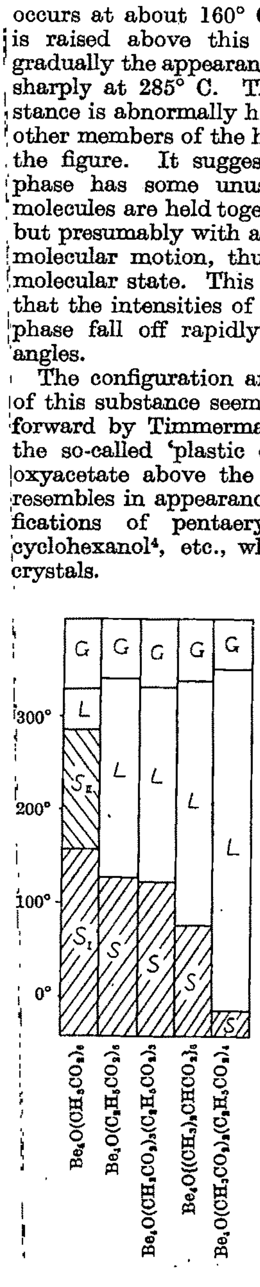
New grants in the social sciences have been made to the Department of Social Science, University of Liverpool (£7,000 over five years), for a study of group relations and an investigation into social factors of town planning; to the Social Research Division of the London School of Economics and Political Science (£20,000 over five years) towards a comprehensive study of social selection and differentiation with particular reference to the middle class; and to the Institute of Psychiatry, University of London (£20,000 over ten years), for a long-term investigation of the traditional methods of selecting students in comparison with a procedure using various psychological tests, and relation of the assessment with the subsequent careers of the individuals tested. A further grant of £1,000 to the National Institute of Economic and Social Research is to be used in support of the project, "Lessons of the British War Economy". Substantial starts are reported by the recipients of grants approved last year; the Administrative Staff College has commenced its activities, and the Population Investigation Committee has launched a large-scale field study of the trend of intelligence.

Steady progress is reported towards the realization of the Foundation's fellowship policy of a two-way traffic between the various parts of the Commonwealth and Empire of students of varying seniority and fields of interest. The Dominion medical travelling fellowships scheme has proved so successful that it is being continued, with slight modifications, for a further seven years; and the small scheme to enable practical farmers of England and Wales to study modern farming methods abroad has been extended to Scottish farmers. For medical men in the outlying parts of the African Colonies, the Foundation has made a grant of £30,000 to finance for six years periodic visits by a panel of medical consultants from Britain. Reference has already been made to the grant of £500,000 to the new National Corporation for the Care of Old People. The Foundation's own policy is to continue financial support to this Corporation, but, in conformity with its own interests in the problems of health, it will consider projects of research into causes of ageing. The report pays a tribute to Dr. J. H. Sheldon's report on "The Social Medicine of Old Age", although the publication falls just outside the year under review. Among the miscellaneous grants of the year is £1,000 a year for five years towards the maintenance and extension of the activities of the Universities Bureau of the British Empire (now the Association of Universities of the British Commonwealth).

POLYMORPHISM OF BERYLLIUM OXYACETATE

WE have found a transition of beryllium oxyacetate hitherto unrecorded. The transition occurs at about 160° C., and when the temperature is raised above this point the substance assumes gradually the appearance of soft wax, though it melts sharply at 285° C. The melting point of this substance is abnormally high as compared with those of other members of the homologous series, as is seen in the figure. It suggests that the high-temperature phase has some unusual structure in which the molecules are held together, forming a crystal lattice, but presumably with a higher order of freedom in its molecular motion, thus resembling the melt in its molecular state. This view is supported by the fact that the intensities of X-ray spectra taken with this phase fall off rapidly with increase of diffraction angles.

The configuration and symmetry of the molecule of this substance seem to fulfil the requirements put forward by Timmermans[1] for substances which give the so-called 'plastic crystals'. In fact, beryllium oxyacetate above the transition temperature much resembles in appearance the high-temperature modifications of pentaerythritol[2], tetranitromethane[3], cyclohexanol[4], etc., which are examples of plastic crystals.



The X-ray powder photographs taken with this substance slightly above the transition temperature and somewhat below the melting point are similar, but the relative intensities are not the same. Most of the lines observed can be accounted for as the lattice has a rhombohedral unit with dimensions $a_r = 9{\cdot}72$ kX., $\alpha = 54°\ 20'$, containing one molecule in it (copper $K\alpha$ radiation was used). The arrangement of molecules may be such that the centres of molecules occupy the rhombohedral lattice points; but the existence of a few lines which cannot be accounted for with this unit shows that the translation of the structure is not exactly rhombohedral but one having a lower symmetry.

It has been reported by Preston and Trotter[5] and by Beevers[6] that the symmetry of the Laue photographs of the cubic oxyacetate changes from $T_h - m3$ to $O_h - m3m$ in the interval 30–50° C. Jaffray[7] made a thermal analysis and found that at 40·5 ± 0·5° C. there is a change in the heat capacity curve typical of the λ-type. According to Beevers, this change is due to a change in the parameter values of the carboxyl oxygen atom from (−0·17, −0·06, −0·04) to (−0·17, −0·05, −0·05), as the temperature passes the transition range, thus bringing all the oxygen atoms exactly to the (110) planes. We have re-examined the substance by the Laue photographic method and found that the holohedral symmetry is first attained at 60° C. Moreover, we have found on the photographs taken with the X-ray beam perpendicular to the (111) planes a number of diffuse spots, the intensities of which are enhanced considerably on passing the transition temperature.

A tentative theory is put forward. The symmetry of the molecule in the low-temperature form is $T - 23$, and the higher symmetry of the crystal $T_h - m3$ can be described as containing two kinds of molecules the mirror images of which are arranged regularly in accordance with the symmetry of the space group. If the packing of the molecules be kept as before but the two forms of the molecules be found at random, the symmetry of the crystal would attain the higher one $O_h - m3m$ in a statistical sense. This may be explained in another way as follows. The potential change associated with the rotation of the carboxyl group around the carbon-to-carbon bond parallel to the crystallographic axis would have a maximum when the oxygen atoms pass the (110) plane, and if the height of this barrier be low compared to the thermal energy, the oxygen atoms would pass over this barrier and arrive at another position of minimum energy which lies symmetrically to the (110) plane. This may transform the configuration of the molecule to its mirror image form if the change should occur simultaneously in six carboxyl groups within a molecule. Such may be the mechanism of the above-mentioned transformation.

Another modification of beryllium oxyacetate can be obtained by sublimation[8]. It is reported that this modification is birefringent and unstable at room temperature, transforming gradually when left by itself, or rapidly by grinding, into the cubic modification. The Laue rotating crystal and the moving-film goniometer photographs show that the crystal has a monoclinic unit with $a = 13·75$ kX., $b = 9·24$ kX., $c = 16·21$ kX., $\alpha = 98° 55'$, $Z = 4$ (copper-Kα radiation was used throughout), and the corresponding space group is one of $C_s^1 - Pm$, $C_2^1 - P2$ or $C_{2h}^1 - P2/m$.

Detailed analyses of the structures of different modifications are now going on, and the results will be published later.

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July 15.

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[1] Timmermans, J., *J. Chim. phys.*, **35**, 331 (1939).

[2] Nitta, I., and Watanabé, T., *Bull. Chem. Soc. Japan*, **13**, 28 (1938).

[3] Oda, T., Iida, T., and Nitta, I., *J. Chem. Soc. Japan*, **64**, 616 (1943); Oda, T., and Watanabé, T., *ibid.*, **65**. 154 (1944); Oda, T., and Nitta, I., *ibid.*, **65**, 621 (1944) (in Japanese).

[4] Oda, T., *X-rays*, **5**, 2 (1945) (in Japanese).

[5] Preston, G. D., and Trotter, J., *Nature*, **151**, 166 (1943).

[6] Beevers, C. A., *Nature*, **152**, 447 (1943).

[7] Jaffray, J., *C.R. Acad. Sci., Paris*, **225**, 106 (1947).

[8] "Gmelins Handb. anorgan. Chemie", 8 Aufl., **26**, 152 (1930).

WE have carried out differential thermal analyses of beryllium oxyacetate in order to find accurate transition and melting points and also to examine the heat effect associated with these (Fig. 1). The observed transition and melting points are 148° C. and 286·7° C., respectively. If the sample is heated up to about 250° C. and then cooled to the room temperature, there is observed no transition phenomena in the cooling curve; this behaviour persists, for no transition phenomena is shown by the heating curve obtained on the next day (see curve II). But, when the sample is not heated beyond about 210° C., the transition in the heating curve made on the next day is always observed. The velocity of transition is accelerated by grinding the supercooled sample in an agate mortar. But this effect is somewhat complex. Details of the observation will be reported elsewhere. Comparison of the two peaks in the curves of the thermal analysis reveals that the heat of transition is nearly equal to the heat of fusion.

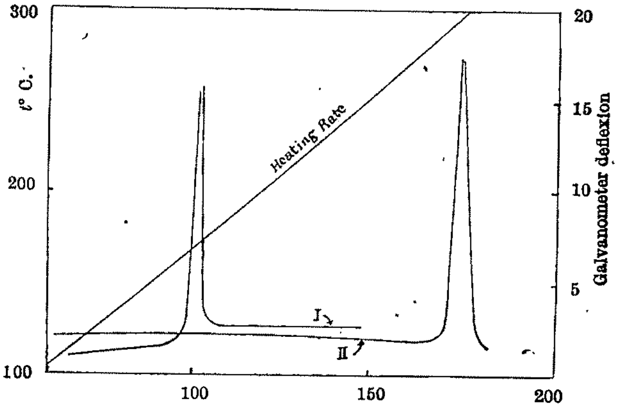

Fig. 1

We have also made a dilatometric investigation. The results are shown in Fig. 2. It is found that the thermal expansion coefficient changes at four different temperatures, namely, 32° C., 42° C., 77° C and 124° C. At all these temperatures except the

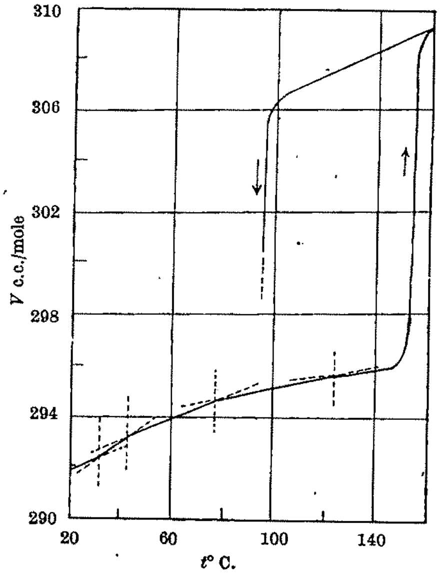

Fig. 2

e expansion coefficient decreases on the high- ature side. The second one corresponds to the ture observed by Jaffray in his calorimetric ment and reported as 40·5 ± 0·5° C. The f such changes is the largest, and the last is llest. The volume change at 148° C. is nearly cent of the volume at 25° C. Numerical data e changes and the volume change at the point not described here will be given else-

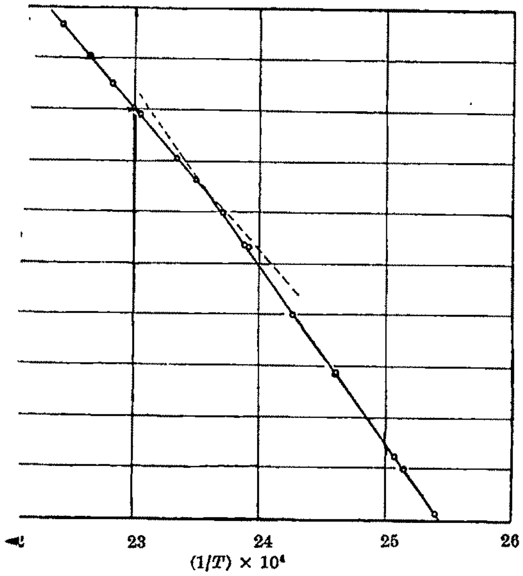

Fig. 3

have also measured the sublimation pressure of bstance below and above the transition points by usion method. The vapour pressure equation ed below the transition point is log $P =$ $4{\cdot}8/T + 15{\cdot}0299$, and above is log $P =$ $2{\cdot}8/T + 12{\cdot}6266$ (Fig. 3). From these equa- the heat of sublimation and of transition as s the entropy changes are calculated (see . The entropy change at the melting point is ated by comparing the areas of the two peaks curve of the thermal analysis with the heat of tion obtained from the vapour-pressure measure- These entropy data seem to explain why this nce has a very narrow range of liquid state in st to other members of the homologous series.

$H_{\text{subl.}}$ $\frac{\text{kcal.}}{\text{mole}}$	$\Delta H_{\text{trans.}}$	$\Delta S_{\text{trans.}}$ e.u.	ΔS_{fusion}
low-temp. phase) high-temp. phase)	4·6	11·0	11·6

are now attempting to measure the heat ity of this substance. Discussion of the mech- of this transition phenomena will be given

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SEED STORAGE OF INDIAN FOREST PLANTS

Mr. T. V. Dent, of the Indian Forest Service, has published some valuable information on the theoretical and practical aspects of seed storage, together with a discussion of the near-related principles of the duration of seed viability, dormancy, germination and the testing of seeds (*Indian Forest Records* (*New Series*) *: Sylviculture*, vol. 7, No. 1 (Manager of Publications, Delhi)). In addition, an attempt is made to screen and correlate all available information on the duration of vitality and on the storage of seed of Indian forest plants.

Mr. Dent writes that it is suggested that the time is now ripe for the initiation of a carefully prepared programme of research into storage of seed and near-related problems, in particular pre-sowing treatments for seeds which are difficult to germinate. Action should be initiated by the central sylviculturist, and an all-India plan of action should be devised, with the co-operation of provincial forest research officers. The shortcomings of our past methods, and the lacunæ in our knowledge of seed storage matters, are revealed by the information tabulated in this record. Here we have our starting point for planning the investigations of the future.

The monograph is divided into two parts, of which Part 1 deals with general principles relating to seed storage and is divided into nine sections covering the following: the practical importance of tree seed storage in forestry, the germination of seeds, dormancy, the duration of seed viability, the collection and extraction of tree seed, methods of seed storage, the protection of stored seed from pests, the transportation of seed and the testing of tree seed. Part 2 deals with available seed storage data for Indian forest plants and includes two tables presenting in summarized form all the principal information which is at present available on the storage and longevity of the seed of Indian forest plants.

In Great Britain it is understood how important is a knowledge of how to store seed of forest trees. It is not surprising, therefore, that India has had to consider this matter carefully, since a very much larger number of tree seeds, both indigenous and exotic, are made use of in the sub-continent of India; at the present time, at least 20,000 acres of land are artificially afforested a year, and under new proposals this area may be very considerably enlarged.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 7

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Electrical Engineering taught to other than Electrical Engineers" (to be opened by Prof. A. A. Hall and Mr. H. C. Mann).

Manchester Geographical Society (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss Dorothy M. Scott: "Southern Rhodesia and the Cape".

Textile Institute (joint meeting with the Society of Dyers and Colourists and the Society of Chemical Industry, at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Dr. E. S. Paice: "Detergents".

Chemical Society, Oxford Section (in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Prof. C. A. Coulson: "Localized and Non-Localized Bonds" (Alembic Club Lecture).

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. A. B. Crawford: "The Life of the Tristan Islanders".

Tuesday, February 8

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Kenneth P. Oakley: "The Origins of Tool-Making".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. Pierre Lépine (Institut Pasteur, Paris): "Virus Research and the Virus Problem".*

Institution of Electrical Engineers, Measurements Section (joint meeting with the Utilization Section, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. T. Winch: "The Measurement of Light and Colour". (To be repeated on Wednesday, March 2, at the City Council Chambers, Clarence Parade, Portsmouth, at 6.30 p.m.)

Institution of Electrical Engineers, East Midland Centre (at the Y.W.C.A., Nottingham), at 6.30 p.m.—Mr. F. J. Erroll and the Lord Forrester: "Some Projects favourable to Direct-Current Transmission, and the Role of the British Electrical Industry in relation Thereto". (To be repeated on Tuesday, April 5, at the Yorkshire Electricity Board Offices, 1 Whitehall Road, Leeds, at 6.30 p.m.; on Wednesday, April 6, at the Cleveland Scientific and Technical Institute, Middlesbrough, at 6.30 p.m.; and on Monday, April 25, at the South Wales Institute of Engineers, Park Place, Cardiff, at 5 p.m.)

British Esperantist Scientific Association (in the Psychology Department, University College, Gower Street, London, W.C.1), at 7 p.m.—Second Annual General Meeting.

Royal Photographic Society (at 16 Princes Gate, London, S.W.7), at 7 p.m.—"Integral Photography" (a paper on the Land Process).

Chemical Society, Edinburgh Section (joint meeting with the Royal Institute of Chemistry, the Society of Chemical Industry, and the Edinburgh University Chemical Society, in the Biochemistry Lecture Theatre, The University, Edinburgh), at 7.30 p.m.—Prof. R. D. Haworth, F.R.S.: "Some Recent Advances in the Chemistry of Natural Products".

Wednesday, February 9

Linnean Society of London (in conjunction with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. John Smart: "Post-Darwinian Development of Taxonomy (Zoology)".

Chemical Society, Northern Ireland Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department Lecture Theatre, Queen's University, Belfast), at 7.30 p.m.—Prof. A. R. Ubbelohde: "Some Problems of the Sensitiveness of Explosives".

Society of Dyers and Colourists, Northern Ireland Section (in the Queen's Hotel, Belfast), at 7.30 p.m.—Dr. T. Vickerstaff: "A Study of the Factors Controlling Dyeing Behaviour".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.30 p.m.—Mr. C. A. Whitmarsh: "Introduction to the Measurement of Radioactivity in a Factory".

Thursday, February 10

Institution of Electrical Engineers, South-Western Sub-Centre (at the Electric Hall, Torquay), at 3 p.m.—Mr. C. A. Cameron Brown and Mr. E. W. Golding: "The Application of Electricity to Horticulture". (To be repeated on Monday, March 14, at the Imperial Hotel, Birmingham, at 6 p.m.)

Chemical Society, Liverpool Section (joint meeting with the Royal Institute of Chemistry, the Society of Chemical Industry and the British Association of Chemists, at the University, Liverpool), at 4.30 p.m.—Dr. G. Gee: "Recent Advances in the Physical Chemistry of High Polymers".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Song of Birds" (to be opened by Mr. James Fisher).

Chemical Society, St. Andrews and Dundee Branch (joint meeting with the Royal Institute of Chemistry, the Society of Chemical Industry and in conjunction with the British Association (Dundee) Trust, in the Chemistry Department, University College, Dundee), at 5.30 p.m.—Dr. W. G. Ogg: "Soil Fertility".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—M. Brocard and M. Hussenot: "French Practical Aerodynamic Methods" (Second Louis Bleriot Lecture).

Royal Meteorological Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Sir Nelson Johnson, K.C.B.: "Some International Aspects of Meteorology".*

Society of Dyers and Colourists, Midlands Section (at the Midland Hotel, Derby), at 7 p.m.—Dr. L. P. Moore: "Some New American Fibres".

Women's Engineering Society (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. E. J. Steadman: "X-Rays in Medicine and Industry".

Friday, February 11

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting.

Chemical Society, Newcastle and Durham Section (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5 p.m.—Dr. A. J. B. Martin: "Partition Chromatography" (Bedson Club Lecture).

North-East Coast Institution of Engineers and Ship
(in the Mining Institute, Newcastle-upon-Tyne), at 6.15
W. L. Hughes: "Vibration of Propeller Blades"; Prof. L.
"Underwater Propeller Tests".

Royal Institution (at 21 Albemarle Street, London, W.
—Mr. Peter Scott: "The Preservation of Wildfowl—T
Problem".

Saturday, February 12

Biochemical Society (at the Westminster Hospital Me
17 Horseferry Road, London, S.W.1), at 11 a.m.—Scienti

British Psychological Society (joint meeting with t
Group of the Physical Society, in the Hastings Hall,
House, Tavistock Square, London, W.C.1), at 2.30 p.m.—
on "The Techniques and Methods of Interpretation of Expe
Colour as carried out by Physicists, Physiologists and Psy

British Psychological Society, Social Psycholog
(in the Physiology Theatre, University College, Gower Stre
W.C.1), at 8 p.m.—Dr. J. C. Flugel: "Some Neglected
World Integration".

APPOINTMENTS VACAN

Applications are invited for the following appointme
before the dates mentioned:

Head of the Department of Pure and Applied Sci
Chemical Engineering—The Registrar, Loughborough
Loughborough (February 12).

Biochemist for the investigation of diseases of farm
The Director, Agricultural Research Council Field Station,
Newbury, Berks (February 14).

Scientific Officers or Experimental Officers with goo
degree in a biological science or in chemistry, with research e
in biochemistry, physiology, pathology, pharmacology or
chemistry, in Ministry of Supply research and development e
ments in Wilts and Hants—The Ministry of Labour and
Service, Technical and Scientific Register (K), York House, K
London, W.C.2, quoting G.550/48 (February 19).

Metallurgists (unestablished, Senior Scientific Officer,
Officer, Experimental Officer and Assistant Experimenta
grades) in Ministry of Supply research and development e
ments in London and South England—The Ministry of La
National Service, Technical and Scientific Register (K), Yor
Kingsway, London, W.C.2, quoting F.1190/48A (February

Physicists and Mathematicians (Experimental Offic
unestablished) in Ministry of Supply research and developme
lishments in Southern England and South Midlands—The
of Labour and National Service, Technical and Scientific Regi
York House, Kingsway, London, W.C.2, quoting A.398/48A
ary 19).

Senior Scientific Officers or Scientific Officers: (a)
(research experience on gaseous combustion at high press
detonation of solid explosives is desirable), (b) Physicist fo
on velocity of detonation of gases at high pressures and mea
of explosion pressures, (c) Chemist for analysis, stability and s
tests on new explosives for industrial use; Experimental
or Assistant Experimental Officers: (a) to assist in new
of physical testing and in the assessment and investigati
plosion and fire risks, (b) for the analysis of explosives samp
in the field, etc., (c) for gas analysis of mixtures of hyd
and other reactants or for physico-chemical work conne
acetylene; in a Ministry of Supply research and developme
lishment in London—The Ministry of Labour and Nationa
Technical and Scientific Register (K), York House, Kingsway,
W.C.2, quoting F.1189/48A (February 19).

Lecturer in Experimental Physiology—The Registr
University, Manchester 13 (February 25).

Statistician in the Department of Social and Ind
Medicine—The Registrar, The University, Sheffield (February

Chemist or Chemical Engineer for fundamental, theoret
experimental work including work on corrosion, a Chemical E
for development of chemical processes subsequent to the la
stage and design of plant from pilot plant to larger scale, a P
for design, development, manufacture and operation of specia
ments, including automatic controls, for chemical plant,
Mechanical Engineer for experimental work on problems
measurement and high-pressure technique and for the d
machines and plant for chemical engineering projects, in the
engineering section of a Ministry of Supply research and deve
establishment in Essex—The Ministry of Labour and National
Technical and Scientific Register (K), York House, Kingsway,
W.C.2, quoting F.1188/48A (February 19).

Professor of Organic Chemistry, and a Professor of T
ical Physics, at the University of Cape Town—The S
Association of Universities of the British Commonwealth, 32
Square, London, W.C.2 (March 31).

Director—The Registrar, Indian Institute of Science, Ban
India (April 11).

Scientist (Grade III, with honours degree in physics and
ably, experience in electronics) in the Scientific Branch,
Western Division of the National Coal Board—The Divisiona
lishment Officer, National Coal Board, 47 Peter Street, Manc

Lecturer in Physics—The Principal, Derby Technical
Normanton Road, Derby.

Health Physics and Safety Assistant Manager at the M
of Supply Division of Atomic Energy, Springfield Factory, Sa
The Staff Section, Ministry of Supply, Division of Atomic
(Production), Risley, Warrington.

Senior Lecturer in Production Engineering, Machine
and Jig and Tool Practice in the Department of Aircraft Eco
and Production—The Registrar, College of Aeronautics, Cr
Bletchley, Bucks.

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Watson's microscopes
combine ease of
manipulation with
precision of movement
and absolute rigidity

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40	£10
50	£16

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surance Society

(founded 1762)

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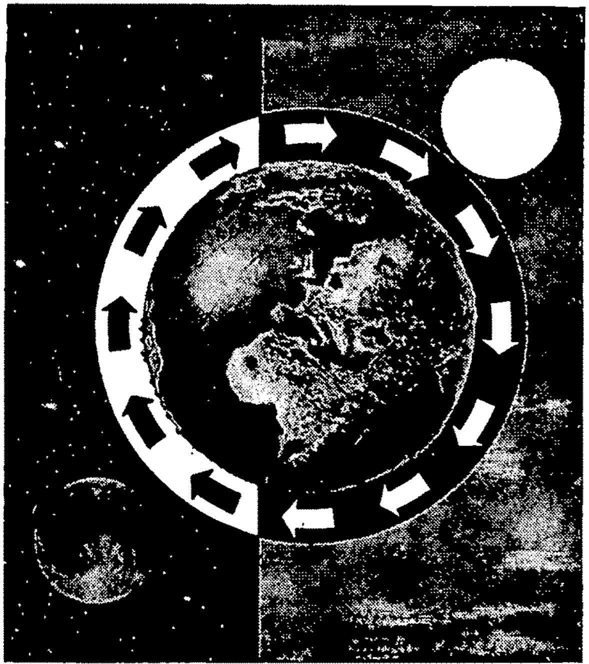

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Noon over Nanking. Dawn over the Atlantic. Blackness over the Andes. In all parts of the world, at all times of the day and night, Marconi built stations are in operation, broadcasting or sending telegraph messages and giving unrivalled service. Wherever ships and aircraft are plying, you will find Marconi apparatus guiding them, every hour of the day, every day of the week. Pioneers in Wireless Communication fifty years ago, Marconi's still maintain their leadership. Behind every new development there will be Marconi's accumulated experience. Behind every new piece of Marconi equipment there will be the honoured name as an assurance of maximum efficiency.

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the greatest name in wireless

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD.,
MARCONI HOUSE, CHELMSFORD, ESSEX.

Available only to applicants excepted from the Control of Engagement Order, 1947, No. 2021, unless the situation is also excepted.

CIVIL SERVICE COMMISSION

Applications are invited from male candidates for the following permanent posts under the War Office.

(1) Senior Grade Engineer.
(2) Main Grade Engineer—Machinery.
(3) Main Grade Engineer—Waterproofing.
(4) Main Grade Engineer—Engineer equipment and refrigeration.
(5) Recruitment Grade Engineer—Internal workshop organization and procedure.
(6) Recruitment Grade Engineer—Workshop planning and layout.

All candidates must be fully qualified engineers, possessing either corporate membership of one of the Institutions of Civil, Mechanical or Electrical Engineers or qualifications entitling them to exemption from parts A and B of one of these institutions' examinations for associate membership: candidates under the latter alternatives must obtain corporate membership of the appropriate institution within two years of entry.

In addition, candidates for the different posts will be expected to have particular qualifications as follows:

For Post (1), must have had considerable experience in man management, preferably as a works manager in mechanical and/or electrical engineering industries; and should be fully acquainted with the piece work system of payment as applied to the engineering industries.

For Post (2), must possess intimate knowledge of workshop practice and layout; be conversant with the operation and characteristics of machine tools and able to compile specifications for same; have a knowledge of the Factories Act; knowledge of rubber and plaster technology desirable.

For Post (3), must possess a knowledge of the practice and theory of water-proofing army equipment and a good knowledge of the design of motor transport and army equipment; knowledge of workshop organization and equipment desirable.

For Post (4), must possess theoretical and practical knowledge of all types of engineer equipment utilized in road-making machinery, dozers, compressors, etc. A good knowledge of the theory and practice of refrigeration equipment is necessary.

For Post (5), must be experienced in workshop organization and administration, general planning and progress methods, time costing, stores accounting and contracts.

For Post (6), must be experienced in workshop planning and layout and the preparation and layout of specialized line system. Must be able to design a workshop to fulfil a particular task.

London inclusive salary scales:

Senior Grade, £1,050–£1,270 (the present vacancy is at Ashford on the scale £997–£1,192).

Main Grade, £750–£1,000.

Recruitment Grade, £475–£750.

Candidates appointed to Senior or Main Grades enter at appropriate minimum. Recruitment Grade commencing salary according to age. Provincial rates somewhat lower.

Age limits:

For Posts (1) to (4), candidates must have attained the age of 30 on January 1, 1949.

For Posts (5) and (6), candidates must be at least 25 and under 35 years of age on January 1, 1949, with extension for regular service in H.M. Forces, and, up to two years, for voluntary service in H.M. Forces otherwise than on a regular engagement or for compulsory national service under the National Service Acts.

Further particulars and application forms from the Secretary, Civil Service Commission, Scientific Branch, 27, Grosvenor Square, London, W.1, quoting No. 2382. Completed application forms must be returned by February 22, 1949.

NEWCASTLE-UPON-TYNE EDUCATION COMMITTEE

RUTHERFORD COLLEGE OF TECHNOLOGY

Principal: H. A. SCARBOROUGH, M.A., D.Sc.

Wanted, for September, 1949, Head of the Mathematics and Physics Department. Ability to prepare candidates for the B.Sc. special degree in mathematics a strong recommendation. Burnham Technical Scale for Grade II Department (£800 × £25–£950, plus training and graduate increments)

Further particulars and application form may be obtained (send stamped addressed foolscap envelope) from the undersigned, to whom completed forms should be returned as soon as possible.

THOS. WALLING,
Director of Education.

City Education Office,
Northumberland Road,
Newcastle-upon-Tyne, 1.

CIVIL SERVICE COMMISSION

The Civil Service Commissioners invite applications for the following posts in the Mechanical Engineering Research Organization of the Department of Scientific and Industrial Research:

(a) One Principal Scientific Officer or Senior Scientific Officer (according to experience and qualifications of the selected candidate) for research on problems of heat exchange. Experience of research and practice in design or operation in this or allied fields is required.

(b) Two Senior Scientific Officers for research on (i) fluid mechanics and (ii) kinematics and mechanisms. For (i) experience of research in modern fluid dynamics, with mathematical ability, is required. For (ii) experience of research on gears or of noise measurement and control would be an advantage.

(c) One Senior Experimental Officer or Experimental Officer (according to experience and qualifications of the selected candidate) to prepare detailed designs of plant, equipment and apparatus for a new hydraulic machinery research laboratory, and later to participate in experimental work therewith. Good design experience essential.

(d) One Senior Experimental Officer (Engineer) for general duties connected with the development of new laboratories, including an engineering workshop. Experience in a responsible engineering position and practical knowledge of modern machine tools would be strong recommendation.

The appointments will be for duty ultimately at East Kilbride, near Glasgow, but in the first instance service in or near London is likely to be required. Candidates must have been born not later than August 1, 1918, for posts (a) and (b) and not later than August 1, 1921, for posts (c) and (d). Candidates for posts (a) and (b) must possess a first- or second-class honours degree or equivalent qualification; for posts (c) and (d) the minimum qualification required is the higher schools certificate or the higher national certificate in engineering or their equivalent, plus experience as indicated.

Inclusive London salary scales are: Principal Scientific Officer posts, £950–£1,250; Senior Scientific Officer posts, £700–£900; Senior Experimental Officer posts, £735–£935; Experimental Officer posts, £525–£675, subject to standard abatements for service outside London, ranging from £30 on a salary of £525 to £73 on a salary of £1,250. Rates for women are somewhat lower. The appointments carry superannuation provision.

Further particulars and application forms from the Secretary, Civil Service Commission, Scientific Branch, 27, Grosvenor Square, London, W.1, quoting No. 2388; completed applications must be returned by February 22, 1949.

MILITARY COLLEGE OF SCIENCE

Shrivenham, Near Swindon, Wilts.

Applications are invited from men only for the post of Lecturer in Mathematics at the Military College of Science under the War Office. Applicants must have the following qualifications:

(1) A university degree in mathematics with first- or second-class honours.

(2) A bias towards applied mathematics is desirable; alternatively, a knowledge of statistics would be a recommendation.

The inclusive London salary scale is £400 × £25–£650, with participation in F.S.S.U.; this scale will be slightly lower in respect of employment outside the London postal area. The post is at present on a temporary basis, but may become permanent later.

Single quarters are available at the College. If, owing to the housing shortage, family accommodation in the neighbourhood cannot be obtained, it may be possible to allot War Department quarters at a fair rent until other accommodation becomes available.

Write, quoting A335/48/A, to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application form, which must be returned completed by February 26, 1949.

ROYAL VETERINARY COLLEGE AND HOSPITAL

Applications are invited for the post of Demonstrator in the Department of Animal Husbandry. Candidates must be members of the Royal College of Veterinary Surgeons or graduates in agricultural science. Salary scale £400 × £25–£500 per annum. Commencing salary will be fixed within this scale according to experience and qualifications.

Applications, stating all appropriate information and giving the names of three persons to whom reference may be made, should be forwarded at once to the Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

IMPERIAL COL
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RESEARCH SC

Applications are invited fo
Senior or Junior Physical Ch
be held at the Imperial Colle
culture, Trinidad.

The applicants for the post
Chemist must have had cons
experience and those for the Ju
two years' research experience
must possess a first- or seco
degree. The successful applican
member of a research team under
Dr. L. F. Wiggins, Ph.D., D.Sc., F
of Research under the Scheme,
mainly on fundamental problems, a
required to work in the chemistry
the University of Birmingham unti
the laboratories are completed in T
two years).

The Senior Physical Chemist w
Senior Lecturer Grade of the College.
salary scale for men is £650 × £25–£
working at Birmingham the salary w
to a reduction of from £15 to £20).
research allowance at present £200 p
a variable cost-of-living allowance of
£125 per annum, will be paid wh
resides in Trinidad.

The Junior Physical Chemist wi
Lecturer Grade of the College. T
salary scale for men is £460 × £25–£6
working at Birmingham the salary w
to a reduction of from £15 to £20).
research allowance at present £100
with a variable cost-of-living allowance
mately £125 per annum, will be paid
officer resides in Trinidad.

The point of entry into either of these
depend upon the age and experience of the
ful candidate.

Pending the establishment of the
Research Service, appointments will be on
for two years in the first instance. W
Service has been established, officers
afforded the option of transferring there
terms applicable to that Service. If an
member of the F.S.S.U. at the time of ap
arrangements will be made to maintain
otherwise, special arrangements provid
benefits will be made, until transfer to th
Research Service.

If unfurnished quarters are provided in
a rent of 8 per cent of the basic sala
charged. Free medical attention at the
provided for the officer and, under cer
tions, for his wife and family.

Long leave of four months every othe
Senior Lecturers), or of six months every
(for Lecturers) is given while employed in
Free passages to and from Trinidad for t
his wife and, under certain circumsta
children will be provided on appointmen
transfer to Trinidad, and on long leave.

The officer may be required to take a s
in the teaching duties at the College.

Application forms are obtainable
Secretary, The Imperial College of Tro
culture, 40, Norfolk Street, London,
whom they should be submitted not lat
month after the date of appearance of th
ment. Candidates from overseas sho
air-letter, giving three references.

COMMONWEALTH BUR
ANIMAL BREEDING
GENETICS

King's Buildings, Edinburgh

Scientific Assistant required for
service and abstract journal, including
of reviews. Applicants should have
degree and a knowledge of languages, in
Scandinavian. Experience in animal ge
desirable. Salary scale £354 × £18–£570.
annuation according to F.S.S.U. Applic
giving age, qualifications, experience, and
references to the Director.

A YOUNG RESEARCH CHEMIST
required in the Central Research and Developm
Department of the Distillers Company, Limit
to work on problems connected with the ma
facture of industrial alcohol. Previous experie
is not essential, but applicants must possess a fi
or second-class honours B.Sc. degree, or equival
and preference will be given to those with sou
analytical training. Commencing salary will depe
upon age, experience and qualifications. Appl
tions should be submitted to the Controlle
Research and Development, The Distillers
pany, Limited, Research and Development
ment, Great Burgh, Epsom, Surrey.

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OLLEGE OF SCIENCE

Near Swindon, Wilts.

ed from men only for the
of Demonstrators at the
Science, Shrivenham, Near
nder the War Office. Details
ogether with qualifications
s, are as follows:

Mathematics. The Demon-
ired to take charge of a small
ratory and to assist in the more
tional work. A university degree
ould be a recommendation.

Ballistics. The Demonstrator
o assist in the maintenance and
instruments, mainly electrical,
measurements; he may also be
supervise their use by students.
uld possess a good working know-
icity and magnetism and of the
electronics.

3) Physics. The Demonstrator will
assist in the maintenance, develop-
vement of a wide variety of scientific
nay also be called upon to supervise
dents. Candidates should have a
nowledge of physics and preferably
egree; some experience of instruc-
ould be an added recommendation.

(4) Chemistry. The Demonstrator's
assist in laboratory instruction and
ork at the standard of a university
A university degree in chemistry,
specialization in physical chemistry,
ommendation.

(5) Metallurgy. The Demonstrator
red to assist in instructional and
work in the metallurgy laboratory.
hould possess a university degree in
an equivalent qualification, together
actical experience.

s should have not been more than
d on August 1, 1948. The inclusive
ry range is £230–£490; the range will
lower for employment outside the
stal area. The initial salary will be
ordance with qualifications and experi-
will be opportunities for private study
h, and Demonstrators will be encour-
ssisted to work for higher degrees or
fications. The College is recognized by
sity of London as an institution for the
e course, and facilities exist for post-
ork. Single quarters are available at the
every assistance will be given in finding
ation for married men.

oting the appropriate reference number,
y of Labour and National Service,
nd Scientific Register (K), York House,
London, W.C.2, for application form,
t be returned completed by March 5,

HMEDABAD TEXTILE DUSTRIES' RESEARCH ASSOCIATION

AHMEDABAD, INDIA

ions are invited from suitable candidates
llowing posts. Full particulars can be
m the Office of the High Commissioner
cientific Liaison Officer, India House,
ndon, W.C.2, to which office applica-
forwarded before March 1, 1949.
dates will receive dearness allowance
revailing rules and will be eligible to
vident fund. Special terms and higher
may be offered to candidates with
alifications.

of the Association. Salary, 1,800×
nds sterling per annum. Qualifica-
tional academic qualifications with a
ten years' experience as leader of
am actively engaged on problems con-
one or more of the following: structure
ties of natural and artificial fibres;
artificial fibres; processing and manu-
xtiles; dyeing and finishing of textiles;
brics. Outstanding personal record

Head of the Department
900×45–1,575 pounds
fications: Specialist in
high academic quali-
ch experience in the
ntrol and study of

221–720 (E.B.)
m. Qualifica-
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WEST OF SCOTLAND AGRICULTURAL COLLEGE

The Governors invite applications for the following posts:

(1) Head of the Horticulture Department. Candidates must hold a degree in horticulture or a degree in science with a diploma in horticulture and have sound practical experience in the subject. Experience of teaching is essential and evidence of aptitude for research and investigational work is required.

Salary scale, Grade I (c), £960, rising to £1,240.

(2) Advisory Officer in Grassland Husbandry. Candidates should have a degree (preferably honours) with experience in advisory, research and experimental work in grassland husbandry.

Salary scale, Grade II (c), £760, rising to £960.

(3) Assistant Lecturer in Zoology. Candidates should have special qualifications in entomology or helminthology.

Salary scale, Grade III (Int.), men, £485 to £780; women, £415–£660.

The posts are superannuable.

Conditions of appointment and application forms are obtainable from the undersigned, with whom applications should be lodged by February 11, 1949.

N. B. BAIN,
Secretary.

6, Blythswood Square,
Glasgow, C.2.

COLLEGE OF AERONAUTICS

A Course of Lectures on "The Aerodynamics of the Helicopter" will be given at the College from Monday, March 7, to Friday, March 18, 1949.

The first week will be devoted mainly to problems of performance and the second week to dynamics, stability and control.

Fees for the course are: tuition fee: for one week. 8 guineas; for the whole course, 15 guineas. Residence charge (including full board), 15s. per day.

Copies of the syllabus and forms of registration can be obtained from the Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks.

A General Course on "Aerodynamics and Fluid Mechanics" will be given at the College from Monday, May 2, to Friday, May 6, 1949.

Fees for the course are, tuition fee: 7½ guineas. Residence charge (including full board), 15s. per day.

Copies of the syllabus and forms of registration can be obtained from the Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks.

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

Notice is hereby given that an Election of Junior Fellows to begin work on October 1 will take place in July, 1949.

Junior Fellowships are normally of the annual value of £600 for three years; but candidates younger than those usually elected, or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £500 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a degree in a faculty of a university in the British Empire or a medical diploma registrable in the United Kingdom.

Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in mental diseases, and in the general allotment of fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates must be received by May 14.

It is necessary for candidates to submit evidence that they can be given accommodation in the departments where they propose to work, which must be either in Great Britain or Ireland.

Forms of application and all information may be obtained by letter only, addressed to Dr. A. N Drury, C.B.E., F.R.S., Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1.

For overseas candidates, forms of application may be obtained from:

The Secretary, South African Medical Council, P.O. Box 205, Pretoria, South Africa.

The Secretary, Universities Commission, Box 4061, G.P.O., Sydney, Australia.

The Department of Health, Wellington, New Zealand.

The Canadian Medical Association, 184, College Street, Toronto, Canada.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

POSTGRADUATE ACADEMIC DIPLOMA IN BACTERIOLOGY

The course for the Postgraduate Diploma in Bacteriology for the Session 1949–50 will commence in October, 1949. This is a full-time day course extending over one academic year.

The course may be taken by:

(a) Graduates in medicine or veterinary science desiring to study bacteriology as applied to medicine and hygiene.

(b) Graduates in science with a first- or second-class honours degree in chemistry, or its equivalent. For such students, the course covers the fields of general bacteriology, chemical microbiology and industrial microbiology.

Applications for admission to the diploma course must be received not later than March 1, 1949.

Further information and application forms can be obtained from the Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

COUNTY BOROUGH OF SOUTHEND-ON-SEA

WORKSHOP STEWARD

Applications are invited for the post of Workshop Steward at the Municipal College upon work principally in connection with the chemical, physical and biological laboratories in the science section.

The person appointed will be responsible for the making, under supervision, of simple apparatus as may be required and for general maintenance. Experience of glass-blowing will be an added qualification.

Salary, Misc. Div. I, i.e., £315×£15–£360. The post is subject to the provisions of the Local Government Superannuation Act. Medical examination.

Applications, stating age, educational qualifications, experience and accompanied by copies of not more than three testimonials, to be forwarded to the Chief Education Officer, Warrior Square, Southend-on-Sea.

ARCHIBALD GLEN,
Town Clerk.

Municipal Buildings,
Southend-on-Sea.

CIVIL SERVICE COMMISSION

Applications are invited for the permanent post of Librarian in the Department of the Scientific Adviser to the Army Council at the War Office. Candidates must have been born on or before August 1, 1917, and must have the following qualifications:

(1) A good scientific background is essential and a university degree in natural science preferable.

(2) Experience of a departmental scientific reference library, including the classification of scientific literature and the preparation of abstracts is desirable.

Inclusive salary scale £525–£675. Rates for women are somewhat lower.

Further particulars and application form from the Secretary, Civil Service Commission, Scientific Branch, 27, Grosvenor Square, London, W.1, quoting No. 2396. Completed application forms must be received by February 24, 1949.

LISTER INSTITUTE

(A) BIOCHEMIST. (B) JUNIOR GRADUATE

Biochemist with research experience required for research and development work of physico-chemical nature in relation to human plasma products at the Institute's Elstree, Herts, laboratories. Salary range £500–£700, according to age and experience.

Also Junior Graduate required for work of an immuno-chemical nature at the Elstree laboratories. Commencing salary £375 or higher, according to qualifications.

Applications for either position, giving experience and qualifications, to the Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1.

COLLEGE OF AERONAUTICS

A General Course on "Certain Problems of Aircraft Structures" will be given at the College from Monday, April 25, to Friday, April 29, 1949.

The Course will include both theoretical and practical work.

Fees for the Course are: Tuition fee, 8 guineas; Residence charge (including full board), 15s. per day.

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FUNCTIONAL APPROACH TO WESTERN UNION

THE announcement on January 29 that the Brussels Treaty Powers had agreed to the formation of a Council of Europe has been described as an event which will go down in history as a milestone of our times. As such it must receive the earnest consideration of all thinking men.

In any such association of nations, the part which scientific workers have to play in the maintenance of peace has frequently been discussed. In November last the Committee on Science and its Social Relations made a report to the International Council of Scientific Unions on an inquiry into this matter, which it had carried out among representative scientific men. The replies showed general agreement that the greatest contribution which men of science can make is to stand firmly for full freedom of thought and expression and movement. This affirmation of the necessity of full intellectual freedom is linked up, moreover, with the recognition of the part which the international scientific unions have to play, as well as the United Nations Educational, Scientific and Cultural Organisation, in pursuit of international understanding and co-operation; and it should be noted that the chairman of the United States delegation to the Beirut Conference of the latter Organisation recorded the emphatic conviction of his delegation that the Organisation could only succeed on the basis of intellectual freedom. The direct contribution of science to the maintenance of peace, it seems, is to be essentially technical, though its indirect influence in other fields may not be negligible. There was little support for the idea that men of science as such could, or should, attempt to court any direct political influence.

Certain aspects of the formation and functioning of Western Union are ably discussed by Miss Barbara Ward in her recent book, "The West at Bay"*. She refers to the Middle East Supply Centre as an example of international planning during the Second World War, remarking that in some of its functions it had to deal with problems closely resembling those facing the association of the nations of Western Europe. Its success in dealing with various technical problems of supply and production then engendered the hope, expressed in these columns (152, 671; 1943; 153, 691; 1944), that it might develop into a very valuable instrument of international co-operation in the Middle East. That hope was frustrated, however, by the withdrawal of the United States at the end of the War.

Yet another instance of successful co-operation in a technical field is cited by Miss Ward to illustrate the feasibility of a Western association. During 1945–47, when it was doing its main work, the United Nations Relief and Rehabilitation Administration included in its formal constitution all the Allies, and its achievements provide convincing evidence of the possibility of running even a system of allocations and priorities on an international basis, provided the political goodwill of the participating nations is secured. Administrators whose ability and independence of mind are beyond question are also essential for success; but the possibility of forging an instrument for international planning cannot now be seriously questioned.

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* The West at Bay. By Barbara Ward. Pp. 234. (London: Allen and Unwin, 1948.) 12*s*. 6*d*. net.

What is at issue is, of course, the way in which it should be used and the extent to which it should attempt to plan. On this Miss Ward points out that national and international experience alike suggest that planned control should be confined strictly to the essentials. Even this measure of world government will demand the sense of a great and overriding purpose and of high moral and spiritual qualities.

When, in conclusion, Miss Ward lays such stress upon those ideas of man's unique greatness but equal fallibility, of his fundamental rights and of the necessary limitations they impose on government, of the existence of an order of right and wrong, and good and evil, from which these rights are derived an which transcend man and society, she comes close indeed to the ideas disclosed and emphasized by the Committee on Science and its Social Relations. The conception of freedom which she elucidates is that which has illuminated all the debates of the past three years on the freedom of scientific work and thought in face of the military demands for secrecy. Her analysis, brief as it is, demonstrates convincingly that, however aloof men of science may keep themselves, as such, from political action, they cannot evade the responsibility for sharing in the challenging and formidable task of discovering the spiritual basis of a Western association.

Without such a basis, the prospects of a Western association of nations are slender. That much has been recognized from the start. Whatever the political means which are chosen to rally the forces of Western Europe, the terms in which Mr. Churchill at The Hague last May defined the conditions for which it is necessary to contend cannot be challenged and should commend themselves to all men of science who recognize what is at stake:

"The movement for European unity . . . must be a positive force, deriving its strength from our common sense of spiritual values. It is a dynamic expression of democratic faith based upon moral conceptions and inspired by a sense of mission. In the centre of our movement stands a charter of human rights, guarded by freedom and sustained by law. . . . After all, Europe has only to arise and stand in her own majesty, faithfulness and virtue, to confront all forms of tyranny, ancient or modern, Nazi or Communist, with forces which are unconquerable; and which, if asserted in good time, might never be challenged again."

To reach agreement on the technical questions of a Western association—such matters as defence, customs, transport, heavy industry and the like—will not be easy: to reach agreement on a political union will be a task of years. The prosaic and functional approach based on the Brussels Pact would seem to be the most practical line of development. It will call for all the help which public and private bodies in every country can give, and the recognition that the movement for Western Union requires such co-operation is an outstanding feature of the Labour Party's recent pamphlet "Feet on the Ground—a Study of Western Union". It is not often that a political party recognizes a mistake and makes amends so handsomely, and that gesture alone should encourage the co-operation from many spheres of life that will be required both to shape the functional instruments and to formulate more clearly in terms of modern life the Western tradition. The Lysenko controversy has brought to the world of science a fresh realization of the danger to the intellectual and spiritual independence which is both an essential element in a creative civilization and a vital part of that Western tradition. Freedom of thought has ever been the secret of all creative epochs and not of scientific advance alone. Scientific workers have their responsibility to rally in support of the maintenance of high standards of truth and taste, now threatened by mass hysteria, both national and class; but they can only fully discharge that responsibility in association with others.

Some of those other contributions were indicated by a meeting held in the Royal Albert Hall last April to demonstrate the support of the Christian community for the idea of Western Union; and on the Anglican side, the report of the Lambeth Conference contained some indications of an attempt to think out afresh the moral and spiritual foundations of Western Europe. The joint congress of the Classical Association and the Hellenic and Roman Societies at Oxford in August also showed that the classics have a place in Western Union and a distinct contribution to make in the formulation of a clearer understanding of the foundations of our Western civilization, with its Greek and Roman as well as Christian elements. That conference, indeed, gave a clue to a way in which the problem of specialization might be solved, and the contribution of the specialists integrated with the need for unity and a common inspiration; it gave an encouraging example of the way in which the professional man, individually and collectively, could help in the renaissance of Western Europe.

That a Charter of Human Rights has now been adopted by the United Nations has no doubt contributed to the achievement of Western Union. It gives concrete expression to one of the affirmations of the preamble to the Brussels Pact, and it should give fresh encouragement to individuals and professional associations to think out and formulate the further measures required both to secure the ultimate objective, and also the widespread understanding of the principles and ideals upon which the effective functioning of a Western association in any form depends. Upon the functioning and co-operation of such groups the preservation of individual freedom and of human rights in general will depend. The contribution of men of science will not be made solely in the technical field. Science itself is one of those cultural activities which has helped to shape the Western tradition. Scientific men in Britain might render valuable service to the cause of a Western association of nations by developing their international contacts in Europe and America. In this way they can help their American colleagues, with whom they share so much of the tradition and ideals of Western Europe, to understand something of the difficulties which make the early federation of Western Europe impracticable, as against a gradual approach to an integration preserving the diversity on which European civilization partly depends.

The war-time experience which led to the creation of such instruments as the Middle East Supply Centre, the Combined Raw Materials Board, the Combined Production and Resources Board, the Anglo-American Caribbean Commission and the Supreme Headquarters, Allied Expeditionary Force (Shaef) has shown the lines on which a form of functional union might be achieved. To secure the forging of such instruments of European union in time of peace requires more than the threat imposed by a 'cold war'. It requires the sense of common purpose, ideals and traditions of which the Brussels Pact is the embryonic expression. In his book "From the League to U.N.", Prof. Gilbert Murray gave last year an account of the work of the Committee of Intellectual Co-operation which shows how important is the task of creating a strong international culture in the defence of peace and feeedom. The task of intellectual co-operation has now passed to the United Nations Educational, Scientific and Cultural Organisation; and the main hope of Western Union and the preservation of the rich heritage of Western civilization may lie not so much in the success of functional co-operation—the crystallization of some sense of common economic and material interests—as in the extent to which that new Organisation, loyally supported and wisely used, is able to make plain, in Gilbert Murray's words, "some sense of values, of obligations, of things of beauty, which are somehow beyond question and which, at whatever cost of endurance, humanity must not betray".

CHEMOTHERAPY AS A SCIENCE

The Basis of Chemotherapy

By Dr. Thomas S. Work and Dr. Elizabeth Work. Pp. xix+436. (Edinburgh and London: Oliver and Boyd, Ltd., 1948.) 26*s.* net.

CHEMOTHERAPY was a term used by Ehrlich to denote the treatment with substances of known chemical composition of an infected host, in such a way as to destroy the invading organisms or to neutralize the toxic action of their products. A chemotherapeutic agent must therefore be a substance which has no action against the host, but specifically attacks the infecting organism and either kills it or renders it susceptible to the defence mechanisms of the host. Until recently, new chemotherapeutic agents have been discovered by accident and then subjected to chemical modification in an attempt to improve their effectiveness. The discovery of such drugs has been followed, often after an interval of many years, by elucidation of the nature of their action. There must, however, come a time when it will be possible to design drugs to inhibit processes peculiar to parasitic organisms and so produce chemotherapeutic agents on a rational basis.

It is doubtful whether there is yet sufficient knowledge of anabolic biochemistry or of the differences between host and parasite to provide such a basis, but Drs. T. S. and E. Work in "The Basis of Chemotherapy" have made a promising attempt to indicate the fundamental lines upon which such a development might be expected to take place. The book begins with a historical account of the development of chemotherapy, and the first half of the book then gives an excellent account of the present knowledge of cellular metabolism. In this section the authors summarize what is known of enzymes and their inhibition, essential metabolites and their relation to growth factors and prosthetic groups, metabolism of carbohydrate, fat and protein, together with outlines of the various oxidation and fermentation cycles involved. Here we have the known metabolism of the bacterial cell; but it should be pointed out, in a book on this subject, that much of this metabolism is common to both host and parasite, and it is very doubtful whether any effective chemotherapeutic agent can interfere in these systems. At present it seems probable that studies on the action of chemotherapeutic drugs will reveal the nature of the underlying essential metabolism rather than *vice versa*.

The discovery of the antagonism between *p*-aminobenzoic acid and sulphanilamide provided the first real indication of a possible mode of chemotherapeutic action, and this subject is examined in detail, together with its extension into the general field of drug antagonism. The authors deal with antagonism of arsenical and heavy-metal drugs and present a critical survey of the possibilities and limitations of the use of metabolite analogues. It is hoped that future editions will include some discussion of the recent reports of antagonism of penicillin and acridines by nucleoprotein and of streptomycin by lipositol, although at the moment such findings merely emphasize the gaps in our knowledge of the underlying metabolism. A point of minor criticism is that the authors several times refer to penicillin as bacteriostatic, whereas much of the later work on this antibiotic indicates that its action is lethal and irreversible.

One of the most interesting aspects of drug action on bacteria concerns acquirement of resistance, and the chapter on this subject forms the most useful and informative in the book. Resistance to penicillin and the sulphonamides is the result of selective growth of resistant mutants; these may arise by production of metabolic pathways alternative to those blocked by the drug, by increased production of the competitive analogue, by production of an enzyme destroying the drug, etc. The authors give an excellent exposition of these aspects and also deal with the possibilities of drug resistance arising other than by mutation as suggested by the work of Hinshelwood and co-workers. Finally, there is an authoritative chapter on the relation between chemical structure and activity. Subjects dealt with here include the variation of activity with structure of surface-active substances, basic dyes and sulphonamides; much otherwise scattered but relevant material on ionization and resonance effects are usefully collected here.

So far as we know at present, chemotherapeutic action can affect the cell in three ways: by alteration of its surface properties, by direct inhibition of an essential enzyme, or by competitive inhibition of an essential metabolism. The authors' avowed object is to "focus attention on the modes of action of drugs rather than upon the synthesis of ever more variants on their chemical structure", and they may be congratulated upon achieving this object. There are no data in the book on either clinical applications or the experimental side of chemotherapy, and both the medical man and the bacteriologist would probably prefer that the title should be modified to "The Biochemical Basis of Chemotherapy". E. F. G.

THEORETICAL ACOUSTICS

Vibration and Sound

By Philip M. Morse. (International Series in Pure and Applied Science.) Second edition. Pp. xix+468. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 33*s*.

DR. P. M. MORSE, who has made a number of contributions to theoretical atomic physics, shows in the present book that the new mathematical techniques which have been developed for the working out of quantum mechanics can be used to analyse such problems as the behaviour of sound in rooms. A course given by him at the Massachusetts Institute of Technology led to the writing of the book. According to the preface to the first edition, which appeared in 1936, it is intended primarily as a text-book for students of physics and of communications engineering.

The first aim is to give the student a general introduction to the theory of vibration and sound, and the second to give him a series of examples of the method of theoretical physics so that he may gain an insight into the way in which a theoretical physicist attacks a problem. Presumably the student of physics whom the author has in mind is one who has approached physics via mathematics, rather than one whose bias is towards experiment. Physics students at universities in Great Britain are not usually expected to devote much time to acoustics, and the intensive mathematical treatment would scarcely be the most effective way of giving them an introduction to the physical principles of recent work in acoustics. Students of mathematical physics will find, however, that they are provided with a systematic exposition of a powerful method of handling many acoustical problems. Research workers in acoustics will be particularly interested in the last chapters, where the theoretical work of Morse and collaborators on absorption and the acoustics of rooms is summarized.

Emphasis is laid on the usefulness of determining the characteristic functions for the normal modes of vibration, the behaviour of a flexible string being examined at some length as the simplest case of a system with an infinite number of allowed frequencies. Vibrations of bars, membranes and plates are then investigated in a similar manner. Analysis of sound waves in air commences with propagation in tubes, in connexion with which the concept of acoustic impedance is first used, followed by a chapter on radiation and scattering, which includes sections on absorption at a surface and transmission through ducts.

The present edition is more than a hundred pages longer than the first one. Some parts have been rewritten; but the main change is the insertion of new material, especially sections dealing with transient phenomena by the technique of the operational calculus. The physical principles underlying the mathematics are well brought out, but there is little attempt to compare the theoretical conclusions with experimental results. Very few references are given, and the reader has to find out for himself in what respects the present treatment differs from that of the classical treatises. For the particular fields which it covers, however, Dr. Morse's book will continue to be of great value.

WORLD FOOD PRODUCTION

Feeding the Human Family

Science Plans for the World Larder. By F. Le Gros Clark. (Sigma Introduction to Science, 11.) Pp. ix+125+8 plates. (London: Sigma Books, Ltd., 1947.) 7*s*. 6*d*. net.

IT would be a thousand pities if the misleadingly modest title of this little book, and its inclusion in a series where it is a manifest misfit, were to prevent its having the widest possible circulation. It might perhaps more aptly have been called "Cold Water on Hot Springs". It is one of those rare books that combines science with humanity, that marries a passion for justice and human rights with a hard logic that faces facts. It is as much, if not more, a book for the expert as for the non-scientific inquirer.

Mr. Le Gros Clark's burning conviction that every man, woman and child in the world, without malefit of race, creed or colour, should have access to a diet that can give optimum nutrition is known to all specialists in relevant branches of science in Great Britain, and to many overseas; this conviction is even more intense than that of many of those who attended the Hot Springs Conference and founded the Food and Agriculture Organisation of the United Nations. But his appreciation of the difficulties confronting any attempt to translate into practice the ideals of the former, or even to achieve the much more limited objectives of the latter, is also greater than that of many other enthusiasts for the full larder as a condition precedent for the full life.

The argument of this short essay is already so concise that it would be folly to attempt further condensation. It covers the ground from consideration of individual, regional and national dietary patterns to world markets; it is concerned as much with the raising of crops and stock as with the transport of processed food from factory to consumer; it recognizes in agriculture an essential industry even more than a way of life. The author, in tackling the contradiction between food surpluses and simultaneous hunger, or indeed famine, has surely made it again abundantly clear that no sincere nutritionist can 'keep out of politics' and yet face the economic issues involved.

Not the least among this book's many virtues is the simple and, generally, attractive and accurate way in which it is written, and not the least among its author's claims to distinction is that the extreme seriousness of his subject never causes him to lose his sense of proportion—or indeed of humour. But perhaps Mr. Le Gros Clark's greatest merit of all is that not only does he see the wood as well as the trees, but that he has also with scrupulous fairness and great technical knowledge examined many of the trees against which some of the world's experts in food and agriculture have been barking their individual and collective shins. He has, moreover, on many occasions shown those experts the way—and generally the only way—in which those trees can be cut down, to make a path through the jungle of anarchic production and inequitable distribution to that world of plenty now so often promised by the United Nations. A. L. BACHARACH

ANALYSIS OF OSCILLATIONS

Frequency Analysis, Modulation and Noise

By Dr. Stanford Goldman. (Radio Communication Series.) Pp. xiv+434. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

THE manner in which this book has been written enables any one of the subjects mentioned in the title to be studied alone; but there are sufficient cross-references to indicate the relationships between them. Much of the material contained in the first section, dealing with Fourier analysis, can be found elsewhere; but it is presented here in a form particularly useful to radio engineers. The author maintains that mathematics should not be regarded merely as a convenient tool or a shorthand language to facilitate the solution of engineering problems, but as a subject exhibiting natural phenomena of its own. In support of this argument he mentions the many scientific discoveries which were made as a result of a mathematical investigation rather than by planned experiment. Certainly the mathematical treatments are presented in such a way that their practical importance is constantly in mind.

The comparatively short section which deals with the basic theory of modulation again contains material which can be found scattered among various text-books; but more than usual attention has been paid to the fundamental similarities and differences between the various types of modulation.

The chapters on noise occupy half the book and are based largely on papers which have been published during the last few years. The importance of a statistical approach to the subject has been given an emphasis which will be particularly valuable to those readers with no previous knowledge of noise phenomena. Random noise, of the type caused by shot-effect in valves and thermal agitation in impedances, has been treated at length; but atmospheric and man-made noise are worthy of more than the brief mention given to them. Space might have been found also for the important subject of crystal noise, and a treatment of the interaction of non-random noise with a signal would have been useful to those concerned with jamming techniques.

The author's teaching experience has enabled him to produce a book suitable for students, in that many queries on interesting side-issues have been anticipated. A useful selection of exercises has been introduced at appropriate points in the text. At the same time, the clear lay-out of the text and diagrams, the full list of contents, and the index make the book equally useful for reference purposes.

In cutting down the mathematics to the essentials, the author has not forgotten those who wish to study the subjects more deeply, and an adequate supply of references to original papers is provided. As is often the case in American publications, however, a number of valuable papers published in British journals find no mention. F. HORNER

SYMPOSIUM ON HORMONES

Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Vol. 2. Edited by Gregory Pincus. Pp. v+427. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 8 dollars.

VOLUME 2 of the "Recent Progress in Hormone Research" is in effect the *Proceedings of the Laurentian Hormone Conference* for 1946. This meeting has become a very successful affair and is widely attended by workers connected with this field. The volume at present under consideration is largely concerned with the metabolism of hormones. It is divided into five parts, and each paper is followed by a summary of the discussion, with the names of those taking part and their comments given in considerable detail. As a rule, discussion reported long afterwards makes poor scientific reading; but it must be stated that in this volume the editors have obviously gone to great trouble to cut out the monosyllabic inanities that so frequently disfigure this type of discussion.

Section 1 is entitled "Physical Methods in Hormone Research" and consists of two papers. The first, by R. N. Jones on the characterization of steroid hormones by ultra-violet and infra-red spectroscopy, is an extremely valuable account of this very modern development in North America. It serves as an excellent introduction to the important and complicated work being performed by Dobriner and his colleagues. It is very difficult for the British reader to appreciate the importance of infra-red spectroscopy, as hitherto we have not had the apparatus. These beautiful self-recording infra-red spectroscopes are commonplace instruments in America, and they greatly speed up the investigation of steroid excretion products. The discussion on this paper is particularly interesting and is opened by Dobriner. The second paper, by Friedgood and Garst, is on the identification and determination of œstrogens by ultra-violet spectroscopy. Here again the European reader can see the enormous importance of these automatic and self-recording instruments. This paper indicates that the excretion of œstrogens, which has hitherto been very unsuccessfully investigated, will now yield results to this type of method, and a new field has therefore been opened.

It is not possible to consider the remaining four sections in the same detail, but they follow the same method of presentation. They are concerned with the control of the pituitary, the metabolism of certain steroid hormones, the hormonal regulation of metabolism, and a final section on clinical endocrinology. This last is particularly interesting and contains three papers. The first, by E. P. McCullagh, is on sex-hormone deficiencies; the discussion following this paper is particularly interesting and can be read with great profit. The second paper is on adrenal cortical tumours and Cushing's syndrome, and is by E. J. Kepler, R. G. Sprague, H. L. Mason and M. H. Power. This again is interesting in that it deals with the excretion products, and it is certainly a very valuable contribution to this subject.

In conclusion, the volume is very definitely an essential one for workers interested in endocrinology. Each section has an adequate series of modern references, and the reader may be certain that if he is familiar with this work he will at least be as up to date as the book itself. E. C. DODDS

Organic Analytical Reagents

By Prof. Frank J. Welcher. Vol. 3. Pp. xi+593. Vol. 4. Pp. xiii+624. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 44*s.* net each.

IT would appear that these two volumes complete the author's survey of organic substances used in analysis. Volume 3 deals with heterocyclic nitrogen compounds, oximes and acidic imino compounds, and volume 4 with a number of groups of compounds, including alkaloids, other natural substances and various classes of dyes. Among the more important sections in volume 3 are extensive reviews of the uses of dimethylglyoxime (60 pages), cupferron (41 pages), and dithizone (83 pages), with detailed discussions of the conditions for their use and the factors determining the stability of the complexes formed with metals. The bibliographies in these three sections alone contain some 670 references to the literature.

The usefulness of these volumes as a work of reference would be much increased by the addition of combined indexes covering all four volumes. The analyst who uses them to find what reagents are suitable for the detection or determination of a given metal will otherwise have to search four indexes in every case. The general arrangement of the organic substances is also in some respects arbitrary; for example, the reagent 8-hydroxyquinoline is found in volume 1 under phenols and not in volume 3 under heterocyclic nitrogen compounds, so that in the absence of a combined index the search for a given organic reagent will also often involve the perusal of more than one list. However, this is a minor point, and there can be no doubt that these volumes are the key to an enormous amount of detailed information and will be of great value to the practical worker. G. M. B.

The Birds of Tropical West Africa

With Special Reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. By Dr. David Armitage Bannerman. Vol. 6. Pp. xxxix+364+14 plates. (London: Crown Agents for the Colonies, 1948.) 35*s.*

AFTER a gap of eight years due to the War and its after-effects, publication of this important work is resumed with the appearance of the sixth volume; and one is glad to note that the remaining two volumes are ready for press. The present volume covers seven families of the Passeriformes; the seventh will deal with the weaver-birds; and the eighth will contain additional information that has meanwhile come to hand on the subjects of the first five volumes. This last will certainly be an essential part of the work, as the first volume appeared so long ago as 1930, and something of the kind would have been necessary even if the period of issue had not been prolonged by the War.

The whole work gives a systematic account of all the species of birds known to occur in the Gambia, Sierra Leone, the Gold Coast and Nigeria. For each species there is given a description, with notes on field identification, and an account of what is known of its range and local distribution and of its habits. Such comprehensive documentation for the avifauna of tropical territories is quite unusual, and the Governments of the four Colonies have done well to sponsor the undertaking. The work will provide an invaluable base-line and guide for all further ornithological studies in the area, about the birds of which there is naturally still a great deal to be discovered. In congratulating the author on the approaching completion of his task, one is also glad to note that the standard of production has been well maintained in this post-war volume.

The Petrography and Petrology of South African Clays

By V. L. Bosazza. Pp. xv+313+18 plates. (Johannesburg: The Author, 39 Barkly Road, Parktown; London: Percy Lund, Humphries and Co., Ltd., n.d.) 42*s.*

THIS volume serves a useful purpose by bringing together a variety of chemical, physical and petrological data which have been obtained by the author and others over a period of years. It deserves to be referred to frequently, and one must regret, therefore, that the arrangement of the text makes reference difficult. The numerous analyses are quoted mainly as illustrations in the development of a general thesis on the nature of clay, and consequently data on the same or neighbouring clay deposits are often widely scattered. The index is not sufficiently complete to repair this fault.

The term 'clay' is interpreted in a wide sense, and analytical data are given on soils, siliceous deposits, iron–alumina hydrates and tillite, as well as on such materials as fireclays and kaolins. There is an almost complete absence of data obtained by modern physical techniques (X-ray diffraction, electron microscopy, differential thermal analysis), and the author's reference to the X-ray method (p. 167) suggests that he does not appreciate its present possibilities.

The book is very legibly reproduced from typescript by the 'Replika' process, but readability is impaired by numerous errors in the original typescript. The voluminous list of general references indicates a thorough acquaintance with the literature of clay mineralogy, and most readers should find in it something new to them. DOUGLAS M. C. MACEWAN

Mereside Chronicle

With a Short Interlude of Lochs and Lochans. By C. F. Tunnicliffe. Pp. 200. (London: Country Life, Ltd.; New York: Charles Scribner's Sons, 1948.) 42*s.* net.

MR. Tunnicliffe's "Mereside Chronicle" is an account of peaceful waters in lovely country settings, where birds of many kinds disport themselves undisturbed.

As a bird artist Mr. Tunnicliffe is not only well known to the ornithological world but also to a wider public. He is skilled in depicting feathered life, having that delicacy of touch which is necessary for the successful portrayal of birds.

The illustrations to this handsome volume are many; that used on the jacket, of Canada geese and goslings, being particularly satisfying, for one reason because the black, white and grey subject is especially suitable for reproduction in monochrome.

It is a pity that some of the lovely subjects could not be reproduced in full colour, for the artist we know is as much master of the brush as he is of pencil and pen.

By the way, Mr. Tunnicliffe does not confine himself to English subjects, and his sketches of divers in the Highlands are full of life, as also are other pictures of Scottish birds. F. P.

CHROMATOGRAPHY AND ION-EXCHANGE

RECENT years have seen the development of many new techniques of importance to the chemist; of these, chromatography and ion-exchange have received special attention of late. A well-attended discussion of these methods, arranged by the Chemical Society, was held on November 25, in the Chemistry Department of the Imperial College of Science and Technology, an afternoon session being devoted to chromatography (including partition chromatography), while ion-exchange was dealt with in the evening.

In opening the afternoon meeting, the president, Sir Ian Heilbron, remarked that this was a new departure for the Society or, more correctly, a return to earlier practice. He paid tribute to Dr. R. P. Linstead, who had been largely responsible for arranging the discussion, and called on him to introduce the speakers and the subject.

Dr. Linstead indicated that although the title of the discussion was wide, it would be limited to chromatography and ion-exchange. These resemble each other in being usually operated in columns in which there occurs the distribution of substance between a solid and a liquid phase in a continuous and moving system. There are similarities also to fractional distillation and solvent extraction. Dr. Linstead said that, in addition to the applications of these techniques, speakers would also deal with the principles underlying them, for many of the failures of earlier workers had been due to a lack of knowledge of fundamentals; in introducing the speakers he gave a particularly warm welcome to Dr. Stig Claesson, of Uppsala, Sweden.

The afternoon discussion was opened by Dr. E. Glueckauf with a paper on "Factors Influencing the Efficiency of Chromatographic Separations". He pointed out that there are three fundamental factors to consider, namely, non-equilibrium, diffusion, and theoretical plate effect, and equations were derived summing the influence of these on the form of the boundary between two solutes. The relation of these factors to such experimental variables as grain size, flow-rate, column diameter, temperature and uniformity of packing was considered, and it was shown that for ion-exchange the non-equilibrium factor is the most important one. From this it can be deduced that there are advantages in having a small grain diameter, a low effluent velocity and a high temperature. In organic chromatography, where equilibrium is rapidly achieved, the predominant factor is the plate effect; with a low separation factor it is desirable to have a small grain-diameter and long narrow columns. Examples were given illustrating these points.

Dr. Claesson, who was warmly received, then spoke on "The Adsorption Analysis of High Molecular Substances", and described some of his recent work on the chromatography of high polymers. For this work some changes have been made in the experimental procedure, for it has been found that the insertion of several smaller column-filters after the first one increases the sharpness of the front boundaries; changes in the concentration of the solution leaving the chromatographic column are followed by changes in the refractive index. The advantages of activated carbon as an adsorbent were referred to, and results obtained with such substances as polymethyl methacrylate, polyvinyl acetate, nitrocellulose, glue, etc., were described. Contrary to the behaviour of substances with low molecular weight, the adsorption of these macromolecular materials decreases with increasing molecular weight, the change of behaviour occurring in the region between 5,000 and 10,000. Frontal analysis has been mainly used; but displacement development and elution analysis have also been employed. The best results are obtained with very dilute solutions, and, by extrapolating to zero concentration, a good approximation of the weight distribution function is obtained. The results also agree with those arrived at by fractional precipitation followed by ultracentrifuging. In the field of high polymers, adsorption analysis is useful in determining the degree of polymerization, in determining the purity of a material, or in obtaining information as to branching or end-groups in a polymer chain.

Dr. A. J. P. Martin, one of the pioneers of partition chromatography, then spoke on "Partition Chromatography in Relation to Other Methods of Purification". The enrichment factor of two substances relative to one another in different phases depends on the difference in the energies required to move them from one phase to the other. The energy can comprise Van der Waals forces, hydrogen bonds, or ionic forces. The influence on the partition coefficient of hydrogen bonding with the solvent was discussed, and it was pointed out that whereas the partition coefficients of serine and alanine are the same, that of tyrosine is much more favourable in collidine than the partition of phenylalanine. With ionic substances on buffered columns it is possible to follow changes in the eluate by determinations of conductivity. An automatic apparatus for collecting fractions and determining conductivity was described, and some of the chromatograms obtained with crude penicillins and other materials were shown.

"The Separation of Inorganic Substances on Cellulose" was then dealt with by Dr. R. P. Linstead. Hitherto, partition chromatography has been applied only to organic substances, but work at the Chemical Research Laboratory at Teddington has revealed that many inorganic separations can be achieved by this technique, whether carried out on paper strips or on columns of cellulose. The method consists in bringing together into contact the inorganic substances to be separated, cellulose and a suitable organic solvent which usually contains acid or some other reagent. The system also contains water, which is present either as a normal constituent of the cellulose or through deliberate addition to the solvent. Activation of the cellulose by nitric acid is advantageous in many cases. It was shown that several factors may play a part in these separations, such as sorption on the cellulose, partition between the solvent and water, and complex formation. The technique can be employed for analytical and preparative purposes, and examples of both were given. Actual separations were demonstrated during the lecture.

The final speaker at the afternoon session was Dr. C. E. Dent, who described the separation of amino-acids and polypeptides by partition chromatography. Three methods were dealt with, the silica-gel column, the potato-starch column, and the filter-paper technique in one- and two-dimensional forms. The merits and disadvantages of these methods were discussed. For the study of biological fluids the paper chromatograph has provided the most useful procedure for the separation of complicated mixtures of peptides and amino-acids. Only microgram quantities of material are required, while the resolving power is high. The various spots on a chromatogram can be identified by comparing their position with those of known substances on a standard chromatographic map. Such a map was shown containing more than sixty amino-acids and related substances.

A general discussion followed in which a considerable number of questions were put to the various speakers.

The evening session, under the chairmanship of Dr. R. P. Linstead, was opened with an introductory paper by Prof. C. W. Davies. Prof. Davies pointed out that, in separations of acids on a basic exchanger, the optimum *p*H may be lower than the calculated value, owing to the existence of a zeta potential. He also emphasized that, in organic separations, the simple ionic mechanism may be modified by specific adsorption effects. The non-ionic adsorption of acids on acidic resins may be as high as 1 m.equiv./gm., a value which is of the same order as the total ionic capacity.

The second paper, "The Properties of Ion Exchange Polymers in Relation to their Structure", by N. E. Topp and K. W. Pepper, was read by Dr. Pepper. The influence of macromolecular structure, for example, degree of cross-linking and nature of chemical bonds, on such properties as swelling, solubility and chemical stability was outlined. Curves relating the capacity of an exchanger of known preparation to the equilibrium *p*H were presented. Monofunctional cation exchangers, containing only one type of acidic group, namely, sulphonate alone, carboxyl alone and phenolic hydroxyl alone, were first described. With sulphonated cross-linked polystyrene, the capacity is independent of *p*H over a wide range, and agrees closely with the value calculated from the sulphur content. The capacity of the carboxylic and phenolic exchangers varies with *p*H, and indeed it is not possible to obtain a limiting capacity of the latter material. The capacity-*p*H curves of polyfunctional exchangers, containing, for example, sulphonate and hydroxyl, carboxyl and hydroxyl, consist of segments characteristic of the ionizable groups present. The results emphasize the advantages of monofunctional exchangers in separation work, in that only one set of fundamental data, for example, distribution coefficients, exchange-rates and swelling, is required.

Dr. J. F. Duncan read the paper "Chromatographic Studies of the Sodium–Hydrogen Ion Exchange Equilibrium", by J. F. Duncan and B. A. J. Lister. Elution curves have been obtained for the sodium–hydrogen ion exchange system, and the mass action constant K_a determined by three methods: (*a*) by application of the Glueckauf equation; (*b*) by measurements of the elution volume necessary for solutions of different hydrogen–sodium ion ratios; (*c*) by the batch equilibrium method. The concentrations of sodium ions in each case are measured by use of the 14·8-hour half-life sodium-24 activity. The method is applied to two exchangers, 'Dowex 50', a simple sulphonic acid exchanger, and 'Amberlite I.R. 100H', a mixed sulphonic-phenolic exchanger. The elution curves obtained are independent of the flow-rate in a range of $1 \cdot 75 \times 10^{-3}$ to 10^{-2} cm./sec., showing the system to be in equilibrium. In the case of 'Amberlite I.R. 100H', a further small uptake of sodium ions occurs after the initial break-through due to exchange of the phenolic hydrogen ions. The capacity of 'Amberlite I.R. 100H' at *p*H 7 is 1·63 m.equiv./gm. and at *p*H 11 is 2·52 m.equiv./gm., of which only 1·50 m.equiv./gm. are due to exchange of the hydrogen atoms of sulphonate groups. The capacity for 'Dowex 50' at all *p*H's is 4·3 m.equiv./gm., a somewhat lower value than that given by American workers. With both resins, K_a remains constant for molar fractions of sodium ions in solution which are between 0·2 and 0·8, but rises significantly for molar fractions below 0·1. The values of K_a over the constant range are 1·24 ± 0·015 for 'Amberlite I.R. 100H', and 1·52 ± 0·015 for 'Dowex 50'.

The paper, "Equilibrium Studies with a Cation-Exchange Resin", by J. A. Kitchener and T. R. E. Kressman, was read by Mr. Kressman. He presented a number of interesting generalizations regarding the relative affinities of various cations for a phenol-sulphonate resin. Broadly, the affinities increase with increasing charge, but there is a considerable overlap. Contrary to common assumption, this is not in accordance with a simple Coulomb model. The distance a_0 of closest approach to cation and anion is the determining size-factor for the alkali metals. It may be for divalent ions also, but the effect is largely masked by incomplete dissociation of the salts. In contrast to the simple metal ions, the affinity of large organic cations increases with increasing size up to a limit depending presumably on the pore size of the resin. Incomplete dissociation is an important factor with the thallous and many polyvalent cations, and also with weak acids. The chief effect of concentration is that predicted by the law of mass action for such solid–liquid systems, namely, negligible influence for solutions containing cations of equal valency, and increased adsorption of ions of higher valency with increased dilution. Complex-ion formation may greatly reduce ion exchange, which is also influenced by the nature of the solvent.

This interesting contribution was followed with a paper by Dr. S. M. Partridge, who spoke on "Separation of Amino-acids by Displacement Chromatography on Ion-Exchange Resins". Dr. Partridge described the fractionation of a hydrochloric acid hydrolysis product of commercial egg-albumen on a column of 'Zeo-Karb 215'. Since the amino-acids, tyrosine and phenylalanine, behave irregularly on the column, these are first removed by adsorption on prepared charcoal. The mixture of amino-acid hydrochlorides (containing a small excess of hydrochloric acid) is applied to the column, and the mixed band so obtained is developed by displacement with 0·15*N* ammonia; the effluent solution is collected by means of an automatic arrangement in sixty-four fractions, each of 90 ml. The flowing chromatogram is analysed by paper chromatography, and the results show the presence of seven discrete bands: 1, aspartic acid; 2, glutamic acid, serine and threonine; 3, glycine and alanine; 4, valine and proline; 5, leucine, *iso*leucine, methionine and cystine; 6, histidine and an unidentified substance; 7, lysine. Arginine has a greater affinity for the resin than ammonia, and thus it remains on the column. Modifications in the experimental conditions, which may be used to effect a further separation of the components of the individual bands, were also described.

The last paper, "Ion-exchange Properties of Alginates", by I. L. Mongar and A. Wasserman, was read by Dr. Wasserman. Using a flowing system with highly swollen alginate in fibre form, the ratio k_1/k_2 and the velocity coefficient k_2 have been estimated for the following reaction :

$$\mathrm{Ca}\,Alg + \mathrm{NaCl} \underset{k_2}{\overset{k_1}{\rightleftarrows}} \mathrm{CaNa}\,Alg + \mathrm{CaCl_2}.$$

The calculation of k_2 is based on a knowledge of the diffusion coefficient of calcium chloride in calcium alginate. The value of k_2 obtained is independent of the surface/volume ratio of the gel, and is only moderately influenced by the sodium chloride concentration, pH and temperature.

WIND AND OCEAN CURRENTS

A GEOPHYSICAL Discussion on "Wind and Ocean Currents" was held in the rooms of the Royal Astronomical Society on November 26. The chairman, Dr. A. T. Doodson, emphasized the great complexity of the subject, and gave a brief summary of its various aspects.

The list of problems is headed by the tangential stress between air and water, and this is related to the problems of turbulence in general, and of hydraulic flow. In pipes and channels, the roughness factor remains constant at any one place; but the surface of the sea is hydrodynamically smooth in the early stages of wind action and hydrodynamically rough in the later stages as the waves are developed. It may be expected that there will be considerable variation in the mechanism by which one fluid acts on the other in the varying conditions. The critical velocity of wind for the setting up of waves, as given by Jeffreys (110 cm./sec.), appears to be well established; a second critical value of about 700 cm. per sec., about which there is a rapid change in the stress coefficient, appears to correspond to the change from laminar to turbulent flow. In the earlier stages of development of waves, the surface tension of the water plays a part, but there is still some obscurity with regard to the mode of formation of waves in the initial stages.

After a wave is well established, its growth brings other considerations into prominence. Some investigations by Jeffreys, which showed how the pressure variations on the various parts of the wave influenced its growth, have been supplemented by Sverdrup and Munk, who have added a term depending upon the tractive forces which exist when the waves are well developed.

It is in connexion with well-developed waves that practical interest has lain in recent years. Naval operations off beaches, for example, have stimulated investigations into waves of large amplitudes, in the first place, and thence to associated waves. The laws of decay of wave systems are still somewhat obscure as there are two causes of decay: the air resistance as the wave progresses in calm air, and eddy viscosity. It has been recently stated that the former is the sole factor; but this may be doubted for large waves.

The next stage of the problem is that of the transport of volume. In this the part played by the waves tends to go out of sight, but should not be forgotten. Also the influence of the earth's rotation becomes prominent, though it receives little consideration with regard to the genesis and growth of waves. Ekman's theory of wind-driven currents is well established, but is being developed to allow for the influence of boundaries, at the bottom or near the coasts.

Finally, there is the problem of the gradients of surface set up in restricted seas. In this, further considerations arise, bringing in the variation of depth, the free period of the sea, and the characteristics of the atmospheric disturbances, as well as the decay. The part played by wave action in the absorption of energy in these storm surges may be of some importance. This problem differs from that of waves in deep water in that the bottom friction also is of importance. In this end-problem very striking progress has been made in recent years.

To sum up, the problems range from molecular effects to large-scale effects, and it is their interrelation which needs to be borne in mind when considering the details.

Dr. G. E. R. Deacon pointed out that the energy required to maintain the circulation of water in the oceans can be supplied by the effects of heating, cooling, evaporation and precipitation, and by the stress of the prevailing winds on the surface. Some of the deep-water movements which have velocities of the order of 1 cm. a second may prove to be convection currents, but various lines of investigation show that the surface currents in the oceans, which flow much faster, must derive most of their energy from the wind.

Ekman's theory of wind currents requires that the drift at the surface, in deep water far from land, should be directed 45° to the right of the wind in the northern hemisphere. The average inclination of the surface drift to the wind in different parts of the ocean has been studied by Krummel, Jeffreys, Durst and others, and it proves to be approximately 45°. Jeffreys, interested in the degree of turbulence in wind currents, mentions that this close agreement confirms one of Ekman's basic assumptions, that the eddy viscosity does not change with depth in the water layer affected by the current; but its magnitude, determined by comparing the observed velocities of wind and current, is of the order of 1,000 times as large as the value of eddy viscosity required by Jeffreys's theory of wave generation. This discrepancy is confirmed by recent work, and waves which are known to travel thousands of miles would be damped out in a few hours by viscosities as large as that required to generate wind currents. No explanation has been found for the discrepancy.

Another effect of the wind is the formation of convection cells in the water. Langmuir noticed that weed in the Sargasso Sea became arranged in parallel lines down wind, and showed, by careful measurements in a lake, that such lines mark zones in which the surface water is converging and sinking; midway between them he found that the sub-surface water was rising and diverging. A further study was made in the Gulf of Mexico in winds of force 2–4 by Woodcock. He prepared a hundred special numbered drift bottles, each with the minimum buoyancy to keep it awash at the surface, and rowing a small boat across the wind he threw out one bottle every 2 metres. Within 3–5 minutes, the bottles were always re-formed into new lines parallel to the wind. From Langmuir's work and his own it was known that the water in the convergences moves down wind more rapidly than the water between them, and it was assumed that the leading bottle in each line was dropped nearest a convergence. If the convection cells were symmetrical, the leading bottle in each line should be followed by equal numbers from the left and the right; in all but three of his eighteen experiments, however, there were more from the left, and the average was 60 per cent. He concludes that the right-hand convection cell is most strongly developed.

Attempts have been made to use the effect of the earth's rotation to explain the symmetrical development of the convection cells, but without success. Munk has suggested that the convection cells are combined with a drift of the Ekman type.

Mr. F. Ursell then outlined an investigation of waves as they are affected by the rotation of the earth. It was shown by Stokes that regular trains of water waves are accompanied by a mass transport in the direction of propagation, provided that the effects of non-conservative forces such as the viscous forces and the Coriolis force are negligible so that the waves are free from vorticity. It has been suggested that this transport might set up large-scale ocean currents. However, in geophysical applications, the Coriolis force may not be negligible and vorticity may be generated. This question requires mathematical study. An idealized problem has been considered by Mr. Ursell in which the geopotential gradient (including the centrifugal force) is constant in magnitude and direction; so the wave motion may be thought of as taking place on a plane earth, on which there is a Coriolis field. In the first place, considering regular wave trains which can travel unchanged in such a field, it is necessary to take the non-linear equations of motion, as the mass transport is considerable only for waves of substantial height. But for non-linear equations the principle of superposition does not apply, so that we cannot hope for a complete solution of the equations. (An illustration was given of the difference between linear and non-linear behaviour.) Nevertheless, a good deal can be said about the mass transport. Mr. Ursell began by showing that the plane touching all the crests is normal to the direction of gravity. Then, by an extension of Bernoulli's theorem, it was shown that the mass transport, if any, must be in the direction of propagation. Finally, Bjerknes's theorem on the circulation along a circuit moving with the fluid was used to show that the mass transport at any depth is zero, so that the fluid particles move in closed orbits. The stationary state of waves on a rotating earth must therefore approximate closely to the type studied by Gerstner (1802) rather than to Stokes waves. The foregoing arguments do not apply on the equator.

Bjerknes's theorem may also be applied to the non-stationary state. Consider an area of still water which is being invaded by waves. The motion is initially irrotational, so that the waves formed in this area are initially of Stokes type. As they build up, a mass transport is set up. Bjerknes's theorem then shows that this current changes its direction continuously, the direction turning through four right angles in 12 cosecφ hours, where φ is the latitude. Ocean waves should therefore be accompanied by rotating inertia currents. Such currents have hitherto been explained as set up by a wind drag on the surface which ceases when a current has been established. This requires a large value of the eddy viscosity, which would lead to very rapid damping of the resulting motion. It may be that the wave mechanism described here will serve to explain some known inertia currents satisfactorily, but further measurements of waves are needed before a detailed comparison can be made.

Lastly, Mr. R. H. Corkan gave an account of the derivation of certain constants of the sea, of interest to oceanographers, a by-product of his work on storm surges. These surges are waves of much longer periods than surface waves, and the associated transport of water is of great importance. It might be thought that a single well-developed surge would give information as to the period of the oscillation, and that its rate of decay would give an approximate value of the coefficient of eddy viscosity. It was stated that such a simple method cannot be used for surges experienced in the Thames, since the surge has three main contributions: one from local winds, one from winds over the North Sea, and one from a surge propagated inwards from the north of Scotland and travelling around the North Sea in an anti-clockwise direction. The latter contribution is a passing wave, and its rate of decay cannot be ascertained from observations at a single place, such as are applicable in studying the decay of an oscillation of the sea itself. The removal of such an external effect and the allowance for periodic variations in the winds are necessary before the data can be utilized for the desired constants.

Mathematical formulæ for the oscillation of the sea under the influence of a variable wind were described. These involve the free period of the sea and the eddy viscosity. After the wind dies down, there is a decaying oscillation with the free period, which was quite accurately determined from a large number of surges as 30 hr., and the ratio of the first positive amplitude to the next negative amplitude was shown to be approximately 4, so that the decay is very rapid. Very precise figures could not be given because of the complexity of the phenomenon, but it was shown that the mathematical formulæ were justified only on the assumption of no bottom current; the alternative of finite bottom current would require unduly large current velocities. The decay factor corresponds to a coefficient of eddy viscosity of about 1,300 C.G.S. units.

The relation between wind velocity and elevation, with the damping factor of 4, with certain assumptions as to the effective length of channel over which it operated, gave a stress coefficient of 0·0023 C.G.S. units. This is in good agreement with values obtained by other investigators, and showed that the various results derived from the investigation were in conformity with one another. The need for caution in deducing constants from observations uncorrected for all possible oscillatory causes was fully evident.

There was unfortunately very little opportunity for discussion.

THE KAURI TREE IN NEW ZEALAND

AN article dealing with the controversy over the question of the preservation of the famous kauri tree of New Zealand, with particular reference to the treatment and control of Waipoua Forest, was published in *Nature* of January 10, 1948. The article ended on an optimistic note, as it was felt that it should not be difficult to reach agreement. Unfortunately, that agreement has not been reached, mainly as one side feels unable to accept any compromise and appears convinced that nothing short of constituting the whole 40,000 acres a national park of the type in which nothing may ever be touched would meet requirements.

The latest development is the private publication by Mr. W. R. McGregor of an attractive booklet on the Waipoua Kauri Forest*. In producing this account, Mr. McGregor has done a real service to the wide public in New Zealand and the world over that is interested in the preservation of the best examples of natural vegetation still available for the enjoyment and study of future generations. He has a ready pen, and his descriptions reveal a deep love of the wild forest and an almost fanatic desire to exclude any activity in or near it that may threaten its wildness and solitude. The book is, moreover, profusely and excellently illustrated with fifty-six photographs. No attempt is made to disguise the fact that the author regards the State Forest Service as 'Enemy No. 1'. Indeed, perusal of the book leaves one with the impression that the object of its publication is to try to win popular support for bringing pressure to bear on the Government to withdraw the forest completely from control by the Forest Service and to constitute the whole of it a national park under some other authority on the lines adopted in Canada and the United States. This attitude leads to various charges against the Forest Service which one is reluctant to accept literally, and which, indeed, would be indignantly rebutted by the professional forester the world over.

Like any other Government Department, the Forest Department is the servant of the State, responsible for carrying out the policy of its Government, and Mr. McGregor is clearly on firmer ground when he charges (p. 11) the New Zealand public with "complete failure to develop a forest policy adequate to the needs of this country". It is rightly pointed out that the will of the people should determine the use of public land, and the reasons are marshalled why this particular area should be reserved, not for commercial forestry but as a strict Nature reserve in which no human interference with the natural processes of growth, decay and replacement should be permitted.

The reader is also reminded that ever since the original reservation of Waipoua in 1885 there have been various clear indications that those in responsible positions have viewed the forest as such a reserve. Thus Massey declined to sanction the construction of the public road which now traverses the forest, and, even when in 1926 it was built, the then Prime Minister gave assurances that timber would not be cut, and that the object of the road was only to give access for the public to see the kauri.

We understand that even the much maligned Forest Service has agreed that selected areas of the best kauri-bearing forest, as well as a strip all along the highway and individual trees of outstanding interest, should be excluded from forest management; and the real issue seems to be that of the precise extent of the desired Nature reserve. Mr. McGregor claims that the whole forest (about 40,000 acres, 27,600 being under forest) must be constituted a complete Nature sanctuary to safeguard the kauri, and he will contemplate no compromise. He gives no grounds to substantiate this claim except in the vaguest terms, and intense distrust of the Forest Service seems his strongest argument. Some of these charges are patently biased, while the pen-picture of the managed forest (p. 78) reveals a surprising ignorance of modern forestry objectives and practices.

The constitution of large national parks by Canada and the United States is quoted as a precedent to be followed, and it is urged that New Zealand should constitute such a park to save for future generations the last virgin kauri forest of New Zealand. The former countries have, indeed, many millions of acres of national parks, much of them under forest, in which no fellings are allowed (except for insect-infested or fungus-attacked trees); but they also still have vast extents of productive forests, so that the position is entirely different. The Waipoua proposition, however, clearly needs careful examination, action being stayed in the meantime to leave all possibilities open. The thesis is readily acceptable that though the kauri itself is the outstanding species to be preserved, it is unlikely that this aim can be achieved without equally protecting the native vegetation types with which the kauri is associated, particularly as knowledge of their life-history is still extremely slight. Clearly the areas selected for the preservation of the existing giant kauri should be of such extent as to include adequate samples of the other natural forest communities, some of which may be found to alternate in time with those in which kauri is now present. It can also be accepted that the amount of timber which could be obtained from Waipoua is not of great importance, either as a contribution to the total supply or specifically as special-purpose timber.

It may well be decided that to guarantee the safety of the kauri and preserve the associated vegetation it is not necessary to withdraw 40,000 acres from timber production; but early and full examination of the whole matter by a fully representative committee or commission is urgently needed. If, on the basis of its report, the country, through its elected representatives, decides in favour of the Nature reserve or national park project for a part or the whole of the forest, there should be no further hesitation in declaring that to be the decision, and so end the controversy. It may be instructive to note the action which has been taken by the State of California to preserve the redwoods along the comparatively new Redwood Highway, where relatively small blocks of forest, from a few to a few hundred acres, have been reserved or acquired in one way or another and constituted State parks. The species is adequately preserved in the surrounding forests which are under felling and regeneration by the State or private owners, the special steps being required only for the preservation of outstandingly fine trees or groves easy of access to the public.

There is also an interesting comparison to be made with the proposal now before the public in Great Britain that the State foresters should be empowered to take appropriate action to preserve and ensure the perpetuation of the oldest parts of the New Forest. These remnants are in real danger of disappearance because the requisite powers are at present lacking. In undertaking this task, the Forestry Commission would have no prospect of any financial return but only of additional expenditure.

H. G. Champion

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* The Waipoua Forest: the Last Virgin Kauri Forest of New Zealand. By W. R. McGregor. Pp. 80. (Auckland, N.Z.: The Author, Department of Zoology, University College, 1949.) 5s.

OBITUARIES

Mr. J. H. Coste

JOHN HENRY COSTE died on January 3 at his home at Smallfield, near Horley, Surrey, in his seventy-eighth year. His death further reduces the dwindling number of old Finsbury Technical College students, for it was at this College during 1888–91 that he received, under Meldola, scientific training which served him in such good stead for a long and most useful life. He obtained his first appointment under John Augustus Voelcker, and three years later joined the staff of the Chemical and Gas Testing Department of the London County Council; he remained in this service until his retirement in 1936. His ability was soon recognized, and in 1908 he was appointed chief assistant and in 1912 promoted to the position which is now designated Chemist-in-Chief, Public Health Department. He was always a keen experimenter, and scientific literature, mainly *The Analyst* and the *Journal of the Society of Chemical Industry*, contains no less than fifty papers of which he was either the author or part author. A perusal of these contributions shows him to have been a very versatile worker, for the subjects include petroleum, paint, water, air, milk, coal, sewage, etc., and in addition he was the author of one and part author of two books, on the calorific power of gas, the chemistry of paint pigments and on fuel.

Necessarily the field of his activities was very wide, as covering the scientific aspect of all the work of the premier local government authority in the world. In his later years his chief interests centred in two matters intimately connected with public health, namely, atmospheric pollution and sewage treatment. He was a member of the original research committee of the Meteorological Office on the former subject, that work being transferred later to the Department of Scientific and Industrial Research. After his retirement he was still active in this field right up to the time of his sudden death. Naturally, too, as a successor to the pioneers W. J. Dibdin and Frank Clowes as the senior chemist in the London County Council's service, he was intimately concerned with the sewage disposal problem, and did original work on this subject and its related one of water pollution.

Mr. Coste was a fellow of the Royal Institute of Chemistry and of the Institute of Physics, and served for periods on the council of the former and also on that of the Society of Public Analysts.

His nature was kindly and he was always approachable and willing to help in any problem, official or personal, which was put to him. His sudden passing is a great loss to the many who were privileged to be counted among his friends. C. J. REGAN

Prof. Egon von Schweidler

EGON RITTER VON SCHWEIDLER, formerly professor of physics in the University of Vienna, died on February 12, 1948, in his country home near Salzburg. His death has not hitherto been recorded in *Nature*.

Schweidler's name is familiar to all workers in radioactivity as the co-author of a manual of radioactivity which surpasses the well-known French and English standard works in this field by the range it covers and the completeness of its documentation; the two editions of 1916 and 1927 have been most valuable to generations of physicists and chemists. It was written in collaboration with St. Meyer, with whom Schweidler's name is linked also in numerous experimental papers on radioactivity. Another field in which he worked as an experimental physicist and was an acknowledged authority is atmospheric electricity.

It was, however, a contribution to theoretical physics by which Schweidler exerted the strongest influence on the development of science. At the International Congress on Radiology held in Liège in 1905, he read a paper in which he gave the statistical interpretation of Rutherford and Soddy's law of radioactive disintegration. He showed that the statement that, per unit of time, it is always the same fraction of a radioactive substance which disintegrates, can be true only if the law of large numbers makes its levelling effect felt and obscures the deviations; but these must become obvious as soon as the number of atoms under observation is reduced sufficiently. These 'Schweidler fluctuations' were soon verified by experiment, and thus the chance character of the process of disintegration directly demonstrated.

This erratic behaviour of single atoms seemed in 1905 to be something completely out of step with the rest of physics and confined to radioactive disintegration. However, in 1917 Einstein used an analogous interpretation of the emission of light from an excited atom, and it is well known what a predominant role statistical interpretations now take in quantum mechanics. The credit must go to Schweidler, however, for having recognized the first case in a fundamental paper which, in his history of physics, von Laue calls "a step forward of incalculable importance".

Schweidler was born in Vienna on February 10, 1873; he was a student, a lecturer, and an assistant professor there before he was called to the chair of physics in Innsbruck. This he occupied from 1911 until 1926, when he returned to Vienna as director of one of the physics institutes there. This position he held until his retirement in 1939. He was a member of the Vienna Academy of Sciences and for several years also general secretary and vice-president.

The atomistic school of Vienna, famous for such names as Loschmidt and Boltzmann, has lost in Schweidler another worthy representative.

F. A. PANETH

Mr. G. P. Farran

GEORGE PHILIP FARRAN, who died at his home at Templeogue, Co. Dublin, on January 5 at the age of seventy-two, was connected for nearly fifty years with the Fisheries Branch of the Department of Agriculture there. After a distinguished career at Trinity College, Dublin, he joined the small group of scientific men working, under the late Ernest W. L. Holt, on fishery and marine biological problems in Ireland; and afterwards, in 1900, he entered the service of the Department of Agriculture and Technical Instruction as a naturalist. In 1938 he was promoted to chief inspector of fisheries, a post from which he retired in 1946.

Farran's early papers had ranged over a wide field; but later in life he more or less restricted his activities to the study of planktonic organisms, particularly copepods, and the Irish herrings. As a planktologist he was a recognized authority. For a period of more than twenty-five years he represented Ireland at the annual meetings of the International Council for the Exploration of the Sea. He was elected to membership of the Royal Irish Academy in 1912. A year ago he was elected an honorary member of the Challenger Society for his work in marine biology, and shortly before his death he was preparing to attend one of the joint meetings of the Society in London.

We regret to announce the following deaths:

Mr. W. C. Chesterman, O.B.E., assistant secretary of the University Grants Committee, on January 29, aged fifty-nine.

Dr. F. H. A. Marshall, C.B.E., F.R.S., formerly reader in agricultural physiology in the University of Cambridge, on February 5, aged seventy.

NEWS and VIEWS

Physics at the National Research Council, Canada:

Dr. G. Herzberg

Dr. Gerhard Herzberg has been appointed director, Division of Physics, National Research Council, Canada, in succession to Dr. R. W. Boyle, who retired in October 1948. Dr. Herzberg is a Canadian citizen who has been on the staff of the Division of Physics for some months as a principal research officer, having gone to this post from the Yerkes Observatory, University of Chicago, where he had been professor of spectroscopy for nearly three years. During the preceding ten years, he was research professor of physics at the University of Saskatchewan, Saskatoon, Sask. Before that, he had worked in Germany at Darmstadt and Göttingen, and in the University of Bristol. Dr. Herzberg is a leading authority on spectroscopy and molecular structure, and is the author of three standard text-books and numerous scientific papers. At Saskatoon he established a spectroscopy laboratory for graduate research and thus greatly strengthened the graduate school in physics and chemistry. He and his co-workers made important contributions to interpretation of data on spectral lines of distant stars and of comets. These investigations led up to his work at the Yerkes Observatory, where he built the world's longest multiple optical path (5,000 m. at atmospheric pressure) for the study of planetary atmospheres and to gain information on molecular structure. Using this equipment, he carried out important work on the infra-red absorption spectra of hydrogen, which has made it possible to detect hydrogen in planetary atmospheres. Dr. Herzberg will continue his varied researches in his new post.

Dr. L. E. Howlett, M.B.E.

Dr. Leslie E. Howlett has been promoted to be associate director of the Division of Physics, National Research Council, Canada. Graduating in mathematics and physics in the University of British Columbia in 1927, he went to the University of Toronto as a research fellow, proceeding eventually to McGill University for his doctorate. Since 1931 he has been on the staff of the National Research Council in charge of the optics section. During the War he aided in the development of the optical instrument industry, for which he was awarded the M.B.E. in 1943. He served as chief scientific liaison officer in London and later in Washington. Since July 1948 he has been assistant director of the Division, and his advancement to the post of associate director is a tribute to his success in the organisation and management duties entrusted to him.

Another Big Sunspot

Misty or foggy conditions in Britain on February 4 made it possible to see with the naked eye a big group of sunspots that had grown rapidly after February 1. Another factor which contributed to its 'discovery' by many members of the general public was the favourable position of the spot group near the centre of the disk. At central meridian passage on February 5·4, the group passed within 2° of the centre of the disk, and its area was then greater than 2,000 millionths or 1/500 part of the sun's hemisphere. Although in size the present sunspot was only about half that of the four giant spots seen in 1946–47, it has attracted more general interest, because of the recent atmospheric conditions for its easy visibility, and also because of the earlier big spot group of comparable size a fortnight earlier, with the associated auroral display on January 24–25 (see *Nature*, February 5, p. 203). Observers of the setting sun, seen through the London mist on February 4, could also pick out with the unaided eye two other spots.

Government Expenditure on Universities in England

In a written Parliamentary reply to Mr. Kenneth Lindsay on January 18, Sir Stafford Cripps, the Chancellor of the Exchequer, said that the non-recurrent payments to the Universities in England during the years 1945–49 were as follows: 1945–46, £620,895; 1946–47, £566,996; 1947–48, £1,920,508; 1948–49 (to January 14, 1949), £1,980,686. The principal projects covered by these grants are the purchase of sites and buildings, the erection of new buildings (including new teaching blocks for science and technology and halls of residence) and the provision of new equipment. The amounts paid to individual institutions have varied according to the opportunities for building and the degree of expansion of numbers in an individual centre. Sums in excess of £200,000 are listed as follows: University of London, £1,283,348; University of Durham, £504,011; University of Nottingham, £319,083; University of Birmingham, £292,485; University of Leeds, £270,418; University College of Hull, £240,813; University of Bristol, £230,521; University of Oxford, £217,507; University of Reading, £215,645; University College, Leicester, £213,902.

The Oil Position in 1951

Middle East oil is again prominent in the American Technical Press, this time in a paper entitled "The Place Middle East Oil will occupy in World Markets", read by C. J. Bauer, of the Standard Oil Company, New Jersey, at the annual meeting for 1948 of the American Institute of Mining and Metallurgical Engineers. As is now generally appreciated, the function of Middle East oil, once pipe-lines to the Mediterranean are completed, will be to relieve the strain on western hemisphere petroleum resources, that is to say, the United States and Caribbean region, from which at present most of West European oil is derived. The year 1951 appears to be the crucial factor; by then it is anticipated that the annual world demand will be about 140 thousand million Imperial gallons. This will require new capital investment in the industry of £2,500 million before that year. Consumption is estimated by 1951 in the ratio of 6·3 million barrels per day for the United States as against 4·4 million for the rest of the world; in other words, there should be more petrol available for the so-called Marshall Plan countries which, unhappily, at present constitute the largest petroleum-deficient area in the world. By the same tokens, it is anticipated that the United States will practically cease to export oil and oil products to Europe by 1951, the Caribbean and Middle East regions then being the main sources of supply for Europe. The author stresses the recognition of the four great oil regions of the world, East Mediterranean basin, the Caribbean basin, the Far East basin and the North Polar basin; nowhere else are future oil supplies of magnitude likely to be found. Taking the long view, the bulk of Middle East supplies are destined for Europe; the Caribbean will furnish the major part of oil supplies to the western hemisphere; Asia, Australia and New Zealand will draw mainly on the Far East basin (when rehabilitated); and the North Polar basin, not yet in production, is destined to supply both North America and Russia. This is a far-sighted review of the world's oil situation, and it is presented in a form which, aided by extremely informative diagrams, is readily understandable to the layman. Copies of the paper may be obtained on application to the Anglo-American Oil Company, London.

Science Co-operation Office, Middle East

The Science Co-operation Office, Middle East, of Unesco, in Cairo publishes a list of the scientific papers received at the Office; List No. 2 includes the titles of papers received during March 1–July 31, 1948, in addition to those received from January 1, 1947, and given in the previous list. The titles are again arranged under fourteen headings, the bulk of the entries falling under mathematics (2 pages), chemistry (2), geology and geophysics (2), zoology (2), medical sciences (27), engineering sciences (3), and agricultural science (5). Those under medical sciences are further subdivided and fall chiefly under physiology, biochemistry and pharmacology (3–4 pages), medical microbiology and hygiene, parasitology (4), internal medicine and surgery (5) and dermatology and venereology (2). A list of periodicals and serials normally received, arranged by countries, is also included.

A New Mechano-Electrical Transducer

Recently the U.S. National Bureau of Standards has announced the development by W. A. Wildhack of a new highly sensitive mechano-electrical transducer in which small mechanical displacements are transformed into large changes of resistance, current or voltage. Displacements as small as 10^{-5} in. can be measured directly without the use of auxiliary electrical amplifying devices. A nickel-alloy wire, chosen because of its high resistivity and small change in mechanical properties with temperature, is coiled into a close helical or conical spring such that the initial tension varies along its length. Thus, when the ends of the spring are pulled apart, the turns separate one by one, the electrical resistance varying from that with the spring completely closed (approximately a cylindrical metal tube) to that with the spring entirely open (total uncoiled length of wire). The spring transducer is a very sensitive means of conversion, for any small stretching of the spring results in a correspondingly large change in resistance. Used in combination with other transducers, or in a four-arm bridge of which each arm is a spring-transducer, the new transducer should have many scientific and industrial applications.

Wild Birds and the Land

Increasing interest in wild bird life, both from the economic and natural history points of view, has led to the publication of a bulletin under the above title by the Ministry of Agriculture and Fisheries (H.M. Stationery Office. 2*s.* 6*d.*). The bulletin has been prepared by F. Howard Lancum, advisory ornithologist to the Ministry, who has brought together a large collection of fine photographs by some of Britain's leading bird photographers. Each of the fifty species illustrated is accompanied by a note on its physical characteristics and behaviour patterns, along with a statement on its economic significance where this is known. A concluding chapter on the use and method of constructing nest-boxes and bird-tables adds to the value of a publication which could only be published at its present price on behalf of a Government department.

Fossils at the British Museum (Natural History)

The Department of Geology in the British Museum (Natural History) has now resumed publication of the interesting and informative series of guide-books that were issued at intervals in pre-war years. The exhibition galleries were largely dismantled at the beginning of the War, and the Museum itself was afterwards severely damaged by enemy action. The re-assembling of the exhibits, and the execution of plans for re-arrangement already made in 1938, will require a long time to complete. Meanwhile, as a first step, an exhibit has been set out which is intended to serve as an introduction to the study of fossils. The fossils are stratigraphically arranged, and epitomize the succession of life through geological time. The exhibit also shows how fossils reflect past conditions, and suggests how the various forms of life developed and reacted one on another in diverse environmental associations. The new guide-book, which is primarily intended to be used in conjunction with the exhibit, is entitled "The Succession of Life through Geological Time", the authors being K. P. Oakley and Helen M. Muir-Wood. It is priced at 2*s.* 6*d.*, consists of 92 pages, and includes an adequate number of well-executed black-and-white drawings and four palæogeographical maps. There is also an attractive colour plate, figuring, in natural surroundings, a reconstruction of one of the first birds, *Archæopteryx*, the unique specimen of which, from the Jurassic Limestone of Bavaria, is on exhibit in the Museum. Allowing for the increased costs of production, the price is very modest, and the guide might well prove useful as a supplement to the more orthodox elementary text-books of geology.

Bedfordshire Natural History Society and Field Club

The original Bedfordshire Natural History Society and Field Club was founded in 1875 with fifty-nine members, and its proceedings were published in three volumes covering the years 1875–84. The Society ceased to exist about ten years later, and no record exists to show why a Society that held such promise should have ceased to function after such a short life. In October 1946 a new county Society was formed under the old name. The reports for 1946 and 1947 indicate that the Society has made a good start under Mr. Oliver Pike's presidency and should soon gain its rightful place among similar county societies in Britain. Copies of the Society's journals may be obtained from 11 The Avenue, Flitwick, Bedfordshire.

Breeding of Locusts for Research and Instruction

THE supply of living animals for both teaching and research purposes is a perennial problem for zoological laboratories. The new insecticides are partly responsible for the difficulty which has occurred in recent years in obtaining adequate supplies of cockroaches. For many purposes the locust can take the place of the cockroach, and it has the advantages of being larger, easy to rear in laboratory conditions and, for such a large animal, it has a very rapid life-cycle; the whole life-cycle takes about seven weeks, and only about half that time is required from hatching to the emergence of the adults. Instructions for the breeding and rearing of locusts have now been prepared by the Anti-Locust Research Centre, and copies can be obtained from the Director of the Centre, British Museum (Natural History), London, S.W.7. The Centre is not prepared to sell locusts to anyone, but it will supply them free for certain research projects and, so far as possible, for starting stocks for teaching purposes; adults for class dissection will not be sent.

The Physical Society: Annual Exhibition

THE Physical Society's Annual Exhibition of Scientific Instruments and Apparatus will be held during April 5–8, 1949, in the Physics Department of the Imperial College of Science and Technology, South Kensington. The sessions during which the Exhibition will be open are: April 5, 2–9 p.m.; April 6, 10 a.m.–1 p.m., 2–9 p.m.; April 7 and 8, 10 a.m.–1 p.m., 2–7 p.m. During the Exhibition the following discourses will be delivered: "Some Problems of Wave Diffraction in the Ionosphere", by Mr. J. A. Ratcliffe; "Some Modern Aspects of Scientific Instruments", by Mr. A. J. Philpot; "A Review of the Methods and Instruments used in Energy Measurements of Particles in Atomic Nuclei", by Prof. O. R. Frisch. A film on the liquid idophor or teleidoscope will be shown. The Exhibition will also display entries for the craftsmanship and draughtsmanship competition, which is being revived after a lapse during the war years. This competition is organised to encourage and give recognition to skill and ability in craftsmanship and draughtsmanship among apprentices and learners in the instrument-making industry, and a large number of firms and technical institutions is supporting it. The prize-winning entries will afterwards be shown in the Science Museum at South Kensington.

Management Bulletin

FROM December 1948 the British Institute of Management has been issuing to members and subscribers a *Management Bulletin* concerned with events in the management field as a whole. The first issue includes a list of forthcoming events as well as papers arranged by the Institute for February–May, 1949, with brief notes on the activities of the education department, examinations department and the information and research department, and a list of recent additions to the library. Suggestions and criticisms with regard to the scope and utility of the *Bulletin* are invited.

Seventh Pacific Science Congress

THE Seventh Pacific Science Congress (see *Nature*, September 11, p. 409) is now in session in New Zealand. Thirty countries are participating, and of these the seventy-one United States representatives form a particularly large delegation. These American men of science are representing not only the United States but also the dependent territories, such as the Pacific Islands and Honolulu, and the occupation authorities in Japan. British and American civil air-lines and also the United States Military Air Transport Service have made special arrangements to fly these American delegates from their respective scattered locations to New Zealand. The Royal Society has sent a delegation of six to the Congress (*Nature*, January 1, p. 17).

Announcements

PROF. PIERRE-PAUL GRASSE has been elected a member of the Section of Anatomy and Zoology of the Paris Academy of Sciences, in succession to Dr. Robert Courrier, who has become one of the permanent secretaries of the Academy.

THE Institute of Metals Medal (in platinum) for 1949 of the Institute of Metals has been awarded to Dr. William Hume-Rothery, lecturer in metallurgical chemistry in the University of Oxford, in recognition of his outstanding contributions to the science of non-ferrous metallurgy.

PROF. F. F. NORD, of the Department of Organic Chemistry, Fordham University, New York, has been awarded the 1949 Carl Neuberg Medal of the American Society of European Chemists and Pharmacists.

PROF. K. S. DODDS, head of the Department of Botany and Genetics at the Imperial College of Tropical Agriculture, Trinidad, has been appointed principal scientific officer of the Empire Potato Collection, Commonwealth Bureau of Genetics, Cambridge.

MR. W. K. B. MARSHALL has been appointed assistant director of research of the British Welding Research Association. Mr. Marshall is well known for his work on light alloy and stainless steel welding, and in his new position he will pay particular attention to non-ferrous welding research.

THE officers for 1949 of the Nairobi Scientific and Philosophical Society (see *Nature*, October 23, p. 647) are: *President*, V. A. Beckley; *Vice-Presidents*, Dr. B. A. Keen, Dr. R. M. Dowdeswell and H. E. Watson.

THE Institute of Navigation has arranged a symposium on "Operational Aspects of Marine Radar", to be held at the Royal Geographical Society on February 18, at 2 p.m., under the chairmanship of Sir Robert Watson-Watt. Papers to be presented include two from the U.S. Institute of Navigation. The meeting is open to non-members.

THE W. H. A. Robertson Medal and Premium will be awarded annually by the Institute of Metals to the author or authors of the best paper contributed to the *Journal of the Institute of Metals* on engineering aspects of non-ferrous metallurgy. For the first award, papers published in the Institute's *Journal* from March 1948 to August 1949, inclusive, will be considered.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Influence of Cosmic Radiation on Experimental Tuberculosis

THE results of two series of experiments on the action of cosmic radiation on experimental tuberculosis in mice are reported below. In the first series, eighty mice were injected intravenously in Leyden (sea-level) with 1 mgm. of tubercle bacilli and transported four days later to the Jungfraujoch (3,457 m.).

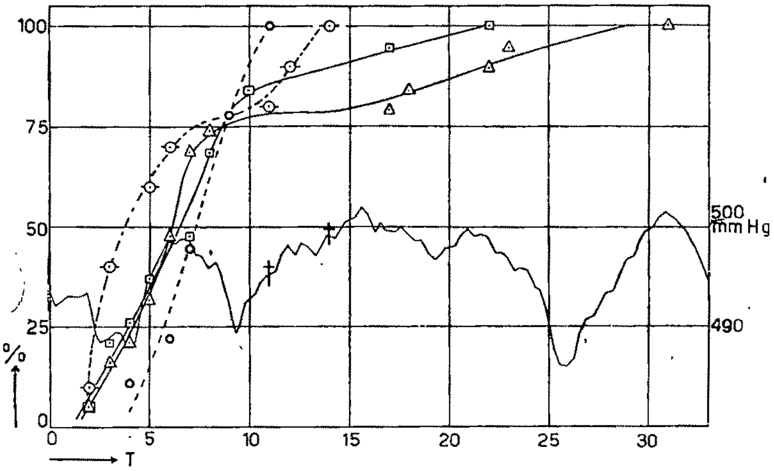

Fig. 1. Mortality curve. *T*, time in days after treatment; △, mice kept in daylight; □, mice screened from cosmic radiation; ○, mice exposed to direct cosmic radiation; —○—, mice exposed to cosmic radiation with 2 cm. of lead

One group was exposed to the direct action of cosmic radiation, a second group was placed under 2 cm. of lead, which gave the maximum intensity of showers, a third group was screened from cosmic radiation, and a fourth group was exposed to daylight and ultraviolet light down to 3,300 A., being thus subjected only to the hard component of the cosmic radiation. The first three groups were placed in a room without daylight, illuminated by a 40-watt electric lamp.

Fig. 1 represents the cumulative mortality curve. The beneficial effect of screening from cosmic radiation can be seen by comparing the curves for mice exposed to cosmic radiation with that for mice screened from cosmic radiation. The beneficial effect of daylight and ultra-violet light can be seen by comparing the curve for mice exposed to daylight with that for mice exposed to cosmic radiation, and that for mice screened from cosmic radiation. By statistical methods, it has been shown that there is no significant difference between the mean times of survival, but there is a significant variation from uniformity of mortality among groups treated alike ($P < 0 \cdot 001$). The different groups of mice are thus not from the same population. The weight of the mice exposed to cosmic radiation with and without absorber is significantly higher than that of the mice screened from cosmic radiation. The last curve has the same form as that of the mice exposed to daylight. Two of the mice exposed to cosmic radiation with 2 cm. of lead developed severe intestinal hæmorrhage; it will be seen from Fig. 1 that these mice died when the barometric pressure was increasing. The mice exposed to direct cosmic radiation showed tremblings during the last weeks, one of them dying with extreme abdominal ascites. It is important to note that three of the mice exposed to cosmic radiation with 2 cm. of lead absorber had only a few tubercles in the lung, whereas all the other mice showed severe lung tuberculosis.

In the second series, sixty mice were injected intravenously with 0·7 mgm. of tubercle bacilli at the Jungfraujoch (3,457 m.). The tubercle bacilli were thus immediately in contact with low oxygen tension in the lung (60 mm. mercury). It has been shown independently by Rich and Follis[1] and Ong, den Dooren de Jong and Schornagel[2] that the histological lesions are markedly inhibited and the mean time of survival is significantly prolonged, when tuberculous mice are kept in an oxygen concentration below 10 vol. per cent. In the early stages of dying, only a few tubercles were found in the lung, but there were tuberculous lesions in the spleen, kidney and liver. In the later stages, we observed severe lung tuberculosis with small or no lesions in the organs, and in these cases there was anoxia and thus the oxygen supply in the body tissues was insufficient. This diminished the lesions in the organs.

There were four groups in the second series: mice kept in artificial light screened from cosmic radiation, mice kept in artificial light exposed to direct action of cosmic radiation, mice kept in artificial light placed under 2 cm. and 10 cm. of lead. As in the first series, we observed hæmorrhages among the mice exposed to cosmic radiation. The hæmorrhages were from the genital organs, mouth, intestines and rupture of the spleen. Three of these mice died during the ascending phase of the barometric pressure and two in the descending phase. As the intensity of the cosmic radiation changes with the barometric pressure, and as none of the mice exposed to the same barometric pressure but screened from cosmic radiation showed any hæmorrhage, we conclude that the hæmorrhage is caused by the variation of intensity of the cosmic radiation.

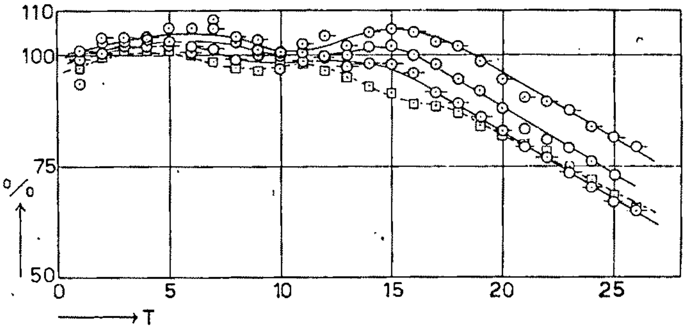

Fig. 2. Weight curve. *T*, time in days after injection. □, Mice screened from cosmic radiation; ⊙, mice exposed to direct cosmic radiation; ⊙—, mice exposed to cosmic radiation with 2 cm. of lead; —⊙—, mice exposed to cosmic radiation with 10 cm. of lead

There is no great difference in the form of the mortality curves of the four groups of mice. Statistical methods show no significant difference between the mean lives, but show significant variation in mortality among groups treated alike. We also conclude that the groups of mice are not from the same population.

As in the first series, the weight of the mice exposed to cosmic radiation is significantly higher than that of the mice screened from cosmic radiation (Fig. 2). Fig. 2 shows that the more the mice were exposed to the soft component and the showers of cosmic radiation, the more the loss of weight is retarded.

I am indebted to Prof. J. Clay for discussions on cosmic radiation; to Prof. D. Chalonge and Mr. F. Egger for determining the transmission spectra for ultra-violet light; to Mr. E. van der Laan for discussing statistical methods; to Dr. W. Mörikofer for the records of barometric pressure at the Jungfraujoch; also to Messrs. U. Camerini, J. A. Gay, D. Ritson and M. A. Roberts for assistance in the cosmic radiation experiments. This research was rendered possible by a grant from the Nederlandsche Organisatie voor Zuiver-Wetenschappelijk Onderzoek.

S. G. ONG

Hochalpine Forschungsstation,
Jungfraujoch,
and
Physiological Laboratory,
Leyden.

[1] Rich, A. R., and Follis, R. H., jun., *Bull. Johns Hopkins Hosp.*, **71**, 345 (1942).

[2] Ong S., G., de Jong, L. E. den Dooren, and Schornagel, H. E., *Proc. Kon. Ned. Akad. v. Wetensch.*, **51**, 106 (1948).

Cross-section for the Disintegration of the Deuteron by 2·76 MeV. γ-Rays

SINCE our recent communication[1], calibrated sources of radiosodium have become available. In view of the high value for the cross-section for photodisintegration of deuterium with radiothorium γ-rays, we decided to repeat our measurements with a radiosodium source. At the same time, several improvements in the apparatus were made; a spherical electrode instead of a cylinder now defines the sensitive volume of the ionization chamber; this avoids the error due to low field at the corners, and reduces the γ-ray background. This improvement, and a slight reduction in valve noise, enable higher counting-rates to be used, and enable pulses of 150-keV. energy to be counted before γ-ray and noise background becomes troublesome. The shielding due to positive ions does not reduce any pulses below this energy, and the correction for this effect is zero; the wall-effect correction is also reduced (4 per cent for radiothorium source, 6 per cent for radiosodium source).

The deuterium concentration was measured at Metropolitan-Vickers Electrical Co., Ltd., with a mass spectrometer which admitted the gas through a needle valve. This obviated the palladium leak separation factor, and gave a result for the deuterium content of the samples 4 per cent higher than that obtained previously (99·2 ± 0·5 per cent deuterium). This agrees with the expected output of our electrolysis plant.

As a check upon the correct operation of the counter, the pulse-height distribution was plotted with a single-channel kick-sorter. The observed distribution was slightly wider than the theoretical distribution. This can be accounted for by positive ion effects and the change in zero due to γ-ray background. When corrections have been applied for these, the ratio of the electric to magnetic photo-effect can be deduced, for the pulse-height distribution can be related to the angular distribution by the principle of conservation of momentum. The results thus obtained are in agreement with those obtained recently in Copenhagen[2] and with other results[3].

A further check is afforded by the ratio of the pulse-heights for disintegration by radiosodium and radiothorium rays. This agrees with the expected value, 1·32, different determinations giving 1·30, 1·31, 1·32, 1·37. The radiothorium source was calibrated as before, using Ricoux's result[4]. An alternative method using the less accurate results of Shenstone and Schlundt[5] would yield a 3 per cent higher value for the cross-section; so also would a method based on the total ionization from radiothorium γ-rays[6], coupled with a knowledge of the γ-ray energies and relative intensities[7]. An aliquot from the sodium source was calibrated at the Atomic Energy Research Establishment, Harwell, by Mr. Putman and Mr. Willment, using a β-γ-coincidence method[8]. The β-spectrum is single[9] and is followed by a 2·76-MeV. and a 1·38-MeV. γ-ray in cascade for every disintegration. There is not more than 1 per cent of β-rays of 2·76 MeV. or higher energy[10]. An intercomparison between their calibration and results using a small graphite-walled ionization chamber has been made by Gray[6], and they agree to within 2 per cent. Altogether, the radiosodium calibration seems to us less subject to doubt than the radiothorium calibration.

Any γ-rays from forbidden lines (RdTh 3·2 MeV. and Na^{24} 4·14 MeV.) would produce more energetic photoprotons. These have been looked for, and upper limits of one part in one thousand and one part in ten thousand respectively can be assigned to these transitions. The decay period of radiosodium has been redetermined as 14·90 ± 0·02 hr.[11].

The results we now present are the mean of five independent measurements; for each filling, a determination was made for both radiosodium and radiothorium; the radiothorium determinations agree within 1½ per cent, which is better than in the case of the sodium determinations, since it includes only the errors in counting, distance measurement and pressure measurement. As a different sodium source was used for each determination, the calibration errors enter into the consistency of the sodium determinations.

Radiothorium cross-section	14·8 ± 1·0
Radiosodium ,, ,,	15·6 ± 1·0
Ratio	1·05 ± 0·08

The theoretical values for the radiosodium cross-section have been kindly sent to us by Prof. Hulthén. The ratio $\sigma_{Na}/\sigma_{RdTh} = 1{\cdot}21$ for a meson mass 296, and 1·22 for meson mass 197. Thus the observed ratio constitutes a certain discrepancy.

Since these measurements were made, a new value for the binding energy of deuterium has been published[12]. The cross-sections for this value (2·237 MeV.) of the binding energy are lower by about 10 per cent.

Detailed results will be published elsewhere in due course.

We have to thank Mr. K. Wood, of Metropolitan-Vickers Electrical Co., Ltd., for analysing the deuterium ; Messrs. J. L. Putman and R. Willment, of the Atomic Energy Research Establishment, Harwell, for the calibration of the sodium source ; Mr. G. R. Bishop, for his help with the measurements ; and Lord Cherwell, for extending to us the facilities of this Laboratory.

R. Wilson
C. H. Collie
H. Halban

Clarendon Laboratory,
Oxford. Dec. 21.

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[2] Lassen, N. O., *Phys. Rev.*, **74**, 1533 (1948).
[3] Graham and Halban, *Rev. Mod. Phys.*, 17, 297 (1945).
[4] Ricoux, *J. de Phys.*, **8**, 388 (1937).
[5] Shenstone and Schlundt, *Phil. Mag.*, **43**, 1038 (1922).
[6] Gray, L. H., *Proc. Roy. Soc.*, A, **263** (1938) and private communication.
[7] Oppenheimer, *Proc. Camb. Phil. Soc.*, **32**, 328 (1936).
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[9] Siegbahn, K., *Phys. Rev.*, **70**, 127 (1946).
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[11] Bishop, G. R., and Wilson, R. (in course of publication).
[12] Bell and Elliott, *Phys. Rev.*, **74**, 1552 (1948).

The Primary Soft Component of Cosmic Radiation

In a recent communication, Rossi[1] analysed burst measurements of Hulsizer[2] and concluded that if a primary soft component exists at all, it constitutes not more than a few per cent of the total primary intensity. In our opinion, Rossi's numerical interpretation of Hulsizer's results is erroneous.

Bursts were observed by Hulsizer containing a minimum of eighty ionizing particles passing through the burst chamber. The cross-section of the burst chamber was 50 cm.^{2} ; it was covered by 2·5 cm. of lead. At a height 0·5 cascade units under the top of the atmosphere, 300 bursts per hour exceeding the minimum size were observed. These bursts were interpreted in the following way : (1) it was assumed that the absorption of any primary spectrum through the atmosphere above the chamber was negligible ; (2) it was assumed that electrons of 4,500 MeV. can give rise to bursts of eighty particles ; (3) it was assumed that half the bursts are not caused by cascade showers but by heavily ionizing particles.

Thus an upper limit for the number of electrons with energies exceeding 4,500 MeV. was derived. Comparison with the total number of incident particles led Rossi to conclude that "not more than 1 per cent of the primaries are electrons with energies exceeding 4,500 MeV.". In our opinion, the calculation requires modification.

(1) The absorption law of a power spectrum of electrons is well known ; given an incident spectrum,

$$S(E;\ 0) = \frac{A}{E^{\gamma+1}}, \tag{1}$$

at a depth of ζ cascade units, we have,

$$S(E;\ \zeta) = \{M(\gamma) \exp\left(-a_1(\gamma)\zeta\right) + N(\gamma) \exp\left(-a_2(\gamma)\zeta\right)\} S(E, 0) \tag{2}$$

(see for details, for example, Jánossy, "Cosmic Rays", p. 237).

With $\gamma = 1\cdot 7,\ \zeta = 0\cdot 5,$

we find

$$S(E_1\ \zeta)/S(E_1\ 0) \sim 0\cdot 5.$$

Thus the primary component is reduced to half its intensity under $\zeta = 0\cdot 5$ (a fraction of this reduction is replaced by photons).

(2) An electron of 4,500 MeV. does not give rise to a shower of eighty particles. But, in any case, a large fraction of shower particles in lead have energies of a few MeV. only, and many of those will be lost by scattering. Thus it seems reasonable to assume that a shower which contains a total of, say, 160 particles, will just manage to produce 80 particles passing through the chamber.

Using the formalism of Bhabha and Chakrabarty, we find that a primary energy of about 20,000 MeV. is required to give rise to a burst of eighty particles in the burst chamber. Thus, accepting other details given by Rossi, we are led to conclude that not more than 2 per cent of the primary cosmic rays are electrons with energies exceeding 20,000 MeV.

If the cut-off of the power spectrum is taken to be at 2,000 MeV., the total number of electrons according to (1) must be less than

$$2 \text{ per cent} \left(\frac{20{,}000 \text{ MeV.}}{2{,}000 \text{ MeV.}}\right)^{1\cdot 7} = 100 \text{ per cent.}$$

Thus no significant upper limit for the strength of the primary component can be derived from Hulsizer's measurements.

I would not go so far as to suggest that Hulsizer's measurements *prove* the existence of a soft component, as there are many *ad hoc* ways of accounting for the experiments. I would like to emphasize, however, that there is to my knowledge no valid experimental evidence against the existence of a primary soft component ; while latitude effect and extensive air showers can most easily be accounted for in terms of a primary soft component forming a moderate fraction (say, 30 per cent) of the total primary intensity. General arguments supporting the existence of a primary soft component have been presented and discussed in detail by Ferretti[3].

L. Jánossy

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[1] Rossi, B., *Rev. Mod. Phys.*, **20**, 537 (1948).
[2] Hulsizer and Rossi, *Phys. Rev.*, **73**, 1402 (1948).
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We are glad that the critical remarks of Jánossy give us an occasion to reconsider the interpretation of our balloon experiments.

We have been aware of the fact that some of the figures quoted in our original paper are inaccurate. Indeed, in a paper presented by one of us at the Cosmic Ray Symposium held in Pasadena last June, a revised estimate of 10 BeV. was given for the minimum energy of an electron capable of producing the observed bursts[1]. We can, however, answer specifically Jánossy's remarks.

(1) Atmospheric absorption. Since our instrument is sensitive to electrons and photons alike, one has to consider the change in the total number of these particles and not that in the number of electrons alone. For vertical incidence and for a power spectrum with $\gamma = 1\cdot 7$, the reduction factor at a depth of 20 gm. cm.$^{-2}$ amounts to 0·7. However, we must consider that the quantity measured by our instrument is closer to the integrated rather than to the vertical intensity. For the integrated intensity the reduction factor is 0·44.

(2) Energy E_0 of an electron which produces a shower of 80 particles through our chamber. The calculations of Richards and Nordheim, which have

just been published[2], show that the proportion of low-energy electrons in a shower from lead is exceedingly large. Thus Jánossy's estimate of 50 per cent for the number of shower electrons which penetrate the chamber wall appears quite reasonable, even though the thickness of this wall is only 0·6 gm.cm.$^{-2}$. However, the production of electrons in the chamber wall by photons from the lead may appreciably reduce the effective absorption. If we do not take this last effect into account, and if we apply the results given by Bhabha and Chakrabarty in their most recent publication[3], we obtain for E_0 a value of 13·5 BeV. This value is arrived at by considering electrons which travel perpendicular to the chamber axis and which traverse on the average 2·8 cm. of lead thickness. Electrons arriving at an oblique angle traverse a greater thickness of lead, and their shower particles travel a longer path in the chamber. Both effects reduce the value of the electron energy corresponding to a given burst size. The correction to E_0 for the effect of oblique incidence is not easy to compute. At any rate, it appears as if Jánossy's estimate of 20 BeV. for E_0 may be excessive, and a value of 10 BeV. such as given at the Pasadena Symposium may represent a more likely estimate.

(3) Low-energy cut-off of the primary spectrum. Balloon experiments of Millikan, Neher and Pickering[4] by means of cosmic ray telescopes failed to reveal any change of the vertical intensity at latitudes greater than 45°. This places the cut-off energy at a value higher than 4 BeV., rather than at 2 BeV., as quoted by Jánossy. (At 45° the limiting energy corresponding to the Størmer cone is 3·8 BeV., that corresponding to Lemaître and Vallarta's main cone, 6 BeV.)

On the basis of the above considerations, one would obtain from our measurements an upper limit of about 11 per cent for the number of electrons in the primary radiation. However, we are very hesitant about this figure, especially because of the great uncertainty of the shower theory for heavy elements.

In conclusion, it is our present opinion that the question concerning the existence of electrons in the primary cosmic radiation is still open and can only be settled by further experiments. One of these experiments, directed at obtaining information as to relative contributions of electron showers and of nuclear interactions to the ionization bursts observed at high altitude under lead, is at present under way.

BRUNO ROSSI
R. I. HULSIZER

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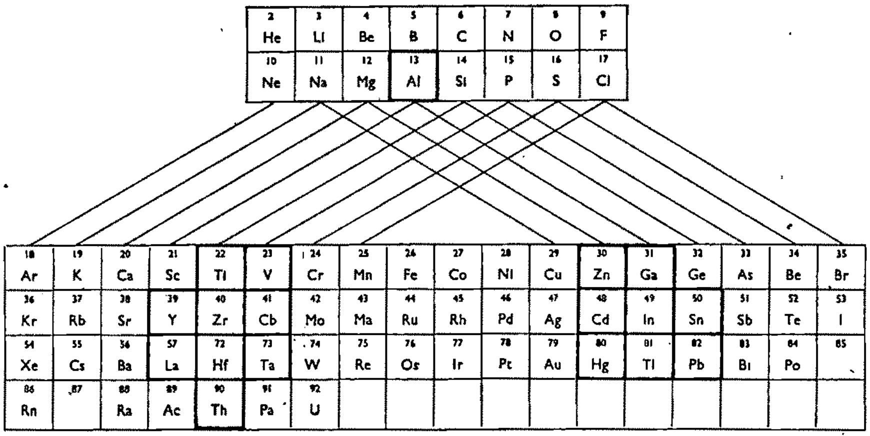
[4] Millikan, Neher and Pickering, *Phys. Rev.*, **67**, 234 (1943).

Theory of Superconductivity

IN two previous notes[1], Prof. Max Born and I have shown that one can obtain a theory of superconductivity by taking account of the fact that the interaction of the electrons with the ionic lattice is appreciable only near the boundaries of Brillouin zones, and particularly strong near the corners of these. This leads to the criterion that the metal should be superconductive if a set of corners of a Brillouin zone is lying very near the Fermi surface, considered as a sphere, which limits the region in the momentum space completely filled with electrons.

It will now be shown that this theory affords an explanation of the fact that the superconductive elements lie exclusively in two columns of the periodic table. In the accompanying table they are marked in rectangular blocks, showing that they lie on either side of the so-called 'transition metals'. These metals are characterized by the fact that in going from one to the next along the periodic table, electrons begin to fill the inner zones which previously remained vacant. Thus the bordering columns must have one of the lower Brillouin zones either completely vacant or just filled ; then the necessary condition of superconductivity that the Fermi surface touches the corners of a Brillouin zone will be satisfied.



2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F
10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl

18 Ar	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Be	35 Br
36 Kr	37 Rb	38 Sr	39 Y	40 Zr	41 Cb	42 Mo	43 Ma	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I
54 Xe	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85
86 Rn	87	88 Ra	89 Ac	90 Th	91 Pa	92 U											

Periodic table: two columns of superconducting elements, marked in rectangular blocks

From these considerations we can deduce a rule regarding the superconductive alloys and compounds. An alloy formed of two elements from different sides of the superconductive columns will have a better chance of being superconductive than any other alloy. The reason is that the lower Brillouin zone for one element is nearly filled, while for the other element it is rather more than filled, and the combination of them (obtained by forming the alloy) satisfies the requirement of superconductivity. For example, alloys like $BiAu_2$, CuS, which are formed from two elements from either side of the superconductive columns, will be superconductive themselves, though both elements are not.

KAI CHIA CHENG

Department of Mathematical Physics,
University, Edinburgh.
Nov. 3.

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[1] *Nature*, 161, 968 and 1017 (1948).

Thixotropic Behaviour of Petroleum Jelly

If the term 'thixotropy' be restricted to Freundlich's original definition of reversible sol–gel transformation, a peculiar manifestation of this property is strikingly shown by petroleum jelly at varying rates of shear. The phenomenon can be demonstrated with no more elaborate apparatus than a 100-c.c. glass cylinder and a perforated disk as piston, mounted centrally on a metal rod terminating in a ring, a similar arrangement to the familiar 'malted milk mixer'. The plunger not only serves to shear the contents of the cylinder, but also as a rough consistometer, the time of travel of the disk between any two graduations on the freely suspended cylinder serving as a measure, provided the rigidity component of consistency of the material is less than the hydrostatic load of the suspended cylinder.

A petroleum jelly of medium consistency serves for the observation. This should be melted, poured into the cylinder and allowed to set for 24 hours, when the consistency will be generally such that no movement of the disk relative to the jelly takes place when the apparatus is suspended by the ring.

If now the plunger be worked up and down very slowly between its lowest position and, say, the 25 c.c. mark, the shearing resistance will be felt to diminish until suspension from the ring will result in a steady upward travel of the disk through the jelly in the sheared zone. Timing is recorded between any two graduated points within the zone of shear. Measurement is repeated by *slowly* returning the disk to its lowest position once more and again noting the time of travel. Repeated measurements lead eventually to a low constant value of consistency, increasing very slowly indeed on resting the material.

When this sheared jelly is now re-sheared by pushing the plunger up and down as quickly as possible, a rapid and progressive growth of consistency is observed, a few churnings resulting in such an increase of rigidity that the disk remains fixed in position as it did in the original unsheared jelly. The transformation from high to low consistency may be repeated as often as desired.

The optical picture is not very clear. The unsheared material shows thin needle-shaped crystals under polarized light, but rather less in amount than the known heterogeneity would lead one to expect. This may, of course, be due to the bulk of the crystals being of a dimension below optical resolution. The field under paraboloid condenser illumination is quite void, indicating similarity of refractive indices of the component phases. The slowly sheared jelly under polarized light shows a great increase of crystallinity, the crystals, however, apparently having the form of shorter, thicker double cones on a common base. The quickly sheared material again shows needles, but of a shorter length, and, while the field of the original jelly shows some incomplete rosettes, these are here absent.

These experiments followed on qualitative observations on a sample of petroleum jelly which had been variously treated by the alternative methods of melting and quickly chilling to a low and a normal temperature respectively, passing through a three-roller mill, a cone mill, a milk homogenizer and a Werner–Pfleider mixer, the subjective consistencies being in the descending order named.

Precision measurements of mobilities by a capillary plastometer and of rigidities by a parallel plate plastometer are in progress of determination.

A. de Waele

Gestetner, Limited,
London, N.17.
Sept. 3.

Recrystallization of Metals under Stress

In *Nature* of September 11, 1948, Prof. E. N. da C. Andrade and also Messrs. Sully, Cale and Willoughby discuss the recrystallization of metals under stress. This phenomenon has been under observation[1–3] in the Metallurgical Laboratories of the University of Melbourne for some fourteen years; and we have reached the following conclusions relating to lead and its dilute alloys.

(1) Industrial virgin lead, so long as it contains less than 0·001 per cent silver, will, in the annealed state, recrystallize under stress when it has reached 4–5 per cent elongation at strain-rates of the order of 10^{-4}–10^{-5} per day. (2) In the 'as rolled' condition, the recrystallization frequently occurs with less than this amount of deformation. (3) The recrystallization is always accompanied by an increase in grain size, the linear dimensions of the grains increasing by a factor of ten. (4) There is a marked increase in creep-rate during recrystallization. (5) The recrystallization starts at one or more centres and spreads throughout the mass. It can be observed at different stages by intercepting the test and re-etching. (6) The progress of recrystallization can be followed without interrupting the test by observing the slip-line system on the test piece. At first, slip lines change direction at the boundaries of the original small crystals; after recrystallization in any area the slip lines are seen to continue across many of the areas defined as crystals by the original etch. (7) Annealing lead at 120° C. for 24 hours removes the facility for recrystallization at creep-rates of the above order. (8) The phenomenon is noted in alloys of lead with less than 0·05 per cent copper, zinc, bismuth, silver, antimony, respectively. In general, the strain needed is higher: an alloy containing 0·001 per cent silver recrystallized after 10 per cent extension in 300 days caused by a load corresponding to an initial stress of 500 lb./sq. in. (9) Additions of less than 0·05 per cent of calcium, magnesium or tellurium respectively appear to eliminate the recrystallization under the conditions used. (10) In pure lead, vibration facilitates recrystallization. With a creep-rate of 10^{-4}–10^{-5} a day, the phenomenon occurs with about 2·5 per cent elongation when a 50-cycle vibration is superposed on a steady stress.

The creep-rates employed by us have always been much lower than those reported by Prof. Andrade. In our opinion the rate of strain has a fundamental effect on the mechanism of creep.

I do not agree that the transition from constant creep-rate to accelerating creep-rate in uniform load tests is necessarily due either to the increased stress or to recrystallization at this stage, except in the case of single crystals. Hirst[4] has shown that single crystals of lead do fail in this manner.

It is interesting to note from the work in the Fulmer Research Institute that the compression-creep curves reproduce the same features as the tensile-creep curves even though the stress is decreasing under constant load.

J. NEILL GREENWOOD

Baillieu Laboratory,
University of Melbourne.
Nov. 2.

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[1] Greenwood and collaborators, *Proc. Aust. Inst. Min. and Met.*, Nos. 95, 101, 104, 109.

[2] Greenwood and Worner, *J. Inst. Met.*, 1 (1939).

[3] Greenwood and Cole. *Metallurgia* (April 1948).

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Planetary Aberration

THE phenomenon of aberration is usually explained in text-books by considering the motion of the earth past a train of light waves. The special theory of relativity, however, tells us that only relative motions are apparent, and so aberration should occur when a light source is moving relative to an observer. In particular, stars having a component velocity perpendicular to the line of sight should produce an aberration effect. In most stars, this would not be observed, since it would be constant; but binary systems, in which one component has large velocities in its orbit, should show aberration effects. The angle of aberration is dependent only on the relative velocities, not on the distance, and has the direction of the velocity. Thus I would expects numerous observations of stars rotating about one another with large (apparent) angular separation but short period (that of average spectroscopics).

Is there something wrong in the above reasoning, or is it that the effects have been observed and not recognized as aberration effects, but included in the intrinsic orbits ? Other possible reasons for not observing the effect are : (1) the spectroscopic binaries from which we deduce the large orbital velocities are not truly binaries, and some other explanation of them must be found ; or (2) if none of the previous suggestions contains the answer, it would appear that an ether had been found, in which case only the observer's motion produces an effect.

Incidentally, the same reasoning applies to any star rotating on an axis nearly parallel to the line of sight—any measurement of diameter would be dependent on the linear velocity of its equator.

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NEITHER classical physics nor relativity supposes that the rays of light from a moving object are curved as a result of its velocity ; the rays which left it at any given time can therefore be prolonged straight backwards (at any later time) until they intersect at the point which it occupied when they were emitted. If a fixed object is also at that point, any observer anywhere will thus see that at the instant of emission the two bodies coincided. Mr. Hines's difficulty has its origin in a misconception ; light leaves the source in *all* directions, not in some specified direction, and although the direction of the particular ray that reaches the observer may depend on the motion of the source, some ray or other will reach him in every case ; and every ray points straight back to the point where the source was at the time of emission. The argument in respect of that particular point is independent of any changes in the velocity of the source, whether before or after, and it thus applies to every point of the orbit of a binary ; if the true orbit were visible as a fixed luminous wire, the star would always be seen on the wire.

Against this background, we may consider the pre-relativity treatment of aberration. In fact, the pre-relativity position already was that to the first order it is only the *relative* motion of the source and observer which matters, for aberration. The subject is treated in some astronomical text-books (for example, Newcomb, "Spherical Astronomy") under 'planetary aberration'. Relativity has extended this statement to all orders; but there is no astronomical case in which higher orders than the first are observable, so that in practice relativity has made no difference. With double stars, however, there is no advantage in considering systems of axes in which first one component and then the other is stationary ; this merely introduces varying displacements of the entire binary system, and is liable to lead to confusion of the sort that has troubled Mr. Hines.

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Tissue Suspensions for Estimations of Radioactivity

THE biologist has frequently to devise an appropriate method for the estimation in a liquid counter of radioactive substances contained in tissues. It is desirable that the technique should be both simple and rapid, and the final fluid medium either a solution of the substance or at least a fine, stable, homogeneous suspension of the total tissue which permits dilution and the removal of representative samples. Coarse suspensions tend to produce erratic counting-rates, due, in part, to drifting of the suspended material into zones of reduced tube efficiency; this can often be verified by shaking such a suspension in the counter after particles have been allowed to settle. In the case of such elements as the halogens, preparation from the tissues of a solution containing the radioactive compound becomes a tedious process if loss is to be avoided, and in these cases a suspension appears satisfactory.

Of the common reagents used for this purpose, solutions of potassium hydroxide are unsuitable, since it is possible to obtain, in a counter of 10 c.c. capacity, counting-rates of more than 400 per minute from the presence of the active potassium (K^{40}) isotope alone. Sodium hydroxide, on the other hand, tends to produce from tissue a troublesome gelatinous mass. Working chiefly with brominated organic compounds, I have obtained satisfactory suspensions by boiling the tissue under reflux in a solution of lithium hydroxide containing 20 per cent of alcohol, afterwards washing out the condensers with a little alcohol. Under these conditions, a suspension is rapidly produced which remains reasonably stable for some hours.

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Mepacrine Hydrochloride in the Treatment of Avian Coccidiosis

As the result of research in Great Britain and in the United States, the use of certain sulphonamides, particularly sulphamezathine, has become the standard method of treatment of acute cæcal coccidiosis of chickens caused by *E. tenella*. The successful results obtained have tended to focus the attention of workers almost entirely on this group of drugs. The purpose of this communication is to report the successful treatment of the disease by mepacrine hydrochloride.

This drug was used extensively in human medicine during the War, chiefly in the suppression of malaria and also in infestations by certain intestinal protozoa. Until recently, records of its use in animals have been confined to the Continent[1–4]; its effective use in an outbreak of bovine coccidiosis has now been reported in Great Britain[5]. In view of the successful treatment of other animals, Continental workers suggested that it might be evaluated in cæcal coccidiosis of chickens, but to the best of our knowledge no report on this work has been published.

In a preliminary experiment, forty chicks, 10 days old, were dosed with sporulated oocysts of *E. tenella*, and 24 hours later were given 0·1 gm. of mepacrine hydrochloride in 4 pints of drinking-water. The chicks were placed in a brooder and kept on a solid floor, which was not cleaned so that infection might be built up. Drinking-water containing mepacrine hydrochloride in the above-mentioned amount was given daily. Seven deaths occurred as a result of acute cæcal coccidiosis. In a control pen of forty chicks given untreated drinking water, twenty-six died from the disease.

In a later experiment, forty chicks, 21 days old, were each given a single dose of sporulated oocysts and placed in a brooder with a wire floor to prevent massive re-infestation, and given drinking-water containing mepacrine hydrochloride (0·1 gm. to 4 pints of water). Seven deaths occurred compared with twenty-three deaths in the control pen.

The drug was well tolerated; one group of chicks, 10 days old, received mepacrine hydrochloride solution in the above concentration in place of drinking-water continuously for six weeks. They drank the medicated water readily, ate well throughout the period of observation and showed no symptoms beyond a slight ruffling of the feathers. Their average weight, however, was 3 oz. less than that of a similar group of chicks given mepacrine hydrochloride continuously for three weeks, followed by ordinary drinking-water during the remainder of the experiment. The average weight of the latter group was that of normal chickens of the same age. Three weeks later, however, the weights of both groups were equal. It would appear, therefore, that even prolonged dosing has no lasting adverse effects.

Mepacrine hydrochloride is readily soluble in water, and in the very weak solution used in these experiments it is both effective and cheap. It is probable that even better results would follow a higher concentration in the drinking-water. One gram to each gallon of water is tentatively suggested; treatment to commence as soon as blood is noted in the droppings and to continue for five to seven days.

Experiments along these and other lines are proceeding, and it seems that mepacrine hydrochloride may become a most useful agent in combating avian coccidiosis, a serious disease of chickens, particularly in the event of the development of strains of coccidi resistant to sulphonamides.

Mepacrine hydrochloride in the form of free-flowin granules prepared by May and Baker, Ltd., unde the trade name of 'Mecryl', was used in the experiments described, and the advice of this firm ha been greatly appreciated.

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Chromatography of Nucleic Acid Derivatives

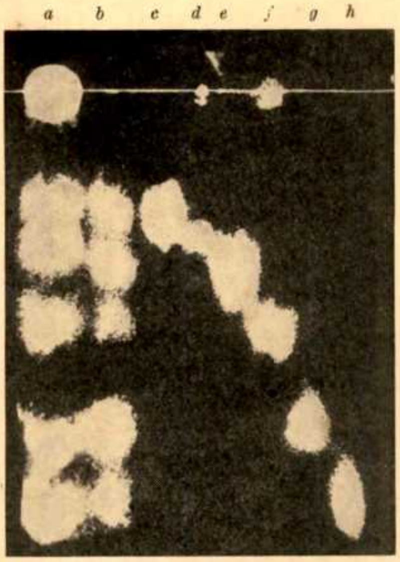
THE nucleic acids and their derivatives ar fundamental constituents of biological systems; bu until recently workers have lacked precise micr methods for their study. Vischer and Chargaff[1], an recently Hotchkiss[2] and also Reichard[3], have show that partition chromatography[4] may be used t separate and characterize certain derivatives. Th methods employed by these workers to detect th spots on the chromatograms were, however, eithe limited in their scope or necessitated the analysis o a large number of fractions selected arbitrarily fro the columns.

We have approached this problem in a differen way. Purine and pyrimidine derivatives are characterized by an intense ultra-violet light absorptio in the region of 2650 A., and they can be detecte in amounts of 10 μgm. or less by a simple photographic technique.

The source of ultra-violet light used in these experiments is a quartz mercury vapour lamp (Hanovi Homesun, 200 V. D.C., 450-watt) fitted with a ventilated shield having an aperture cut opposite th middle of the tube. The light from this is filtere through two quartz filters having a free aperture o 22 mm., one 35 mm. thick, containing dry chlorine and the other 30 mm. thick, containing a salt solutio ($NiSO_4.7H_2O$, 350 gm., $CoSO_4.7H_2O$, 100 gm. pe litre[5]). The light passed by these filters in the ultra violet, mainly the 2537 A. and 2650 A. mercury lines is absorbed by purine and pyrimidine derivatives while the visible light transmitted has no effect o the photographic material used.

Chromatograms run in *n*-butanol in an atmospher containing ammonia on Whatman No. 1 paper ar dried and pinned on to a slightly convex cylindrica surface over a strip of Ilford Reflex Document Pape No. 50. This is then exposed at a distance of 120 cm to the ultra-violet light for 1½ min. and develope in a process developer (Kodak *D*153), fixed, washe and dried. The absorbing substances show up o the black background as light areas (see reproduction) and the corresponding areas of the filter-paper ma be cut out, extracted in water and estimate spectrophotometrically.

While the positions of the various purines, pyrimidines and nucleosides on our chromatograms agre reasonably well with those observed by Hotchkiss



Chromatogram run for 20 hr. in *n*-butanol – water of (*a*) turnip yellow mosaic virus nucleic acid hydrolysed with formic – hydrochloric acid for 4 hr. at 115°. The top spot is due to nucleotides and unhydrolysed nucleic acid ; (*b*) an artificial mixture of the nucleosides and bases known to be in the hydrolysate ; (*c*)–(*h*) the components of the mixture run individually : cytidine, guanine, uridine, cytosine, uracil and adenine

we find that the relative rates of movement of these substances depend greatly on the concentration of ammonia in the vapour phase. For example, the relative positions of uridine and cytidine can be reversed by changing the ammonia vapour pressure. We also find that guanine, if in sufficiently low concentration to dissolve completely in the aqueous phase of the chromatogram, moves at a rate exceeding that of guanosine, and we imagine that it corresponds with the "epiguanine" mentioned by Hotchkiss. We think that the latter used too large an amount of guanine, and as most was undissolved it remained at the zero spot. Hydrolysis of yeast and virus nucleic acids by ammonia according to the method of Levene[6] results in the liberation of part only of the material as nucleosides, and these may be degraded still further. For example, adenosine treated in this way is found to contain four substances : adenosine, adenine and two others, probably inosine and hypoxanthine. The hydrolysis of ribonucleic acid by pyridin–water (Bredereck *et al.*[7]) is far from complete, and the hydrolysate contains at least seven different substances. In fact, we have failed so far to find a method for the quantitative hydrolysis to nucleosides. For hydrolysis of nucleic acid to the bases, the formic–hydrochloric acid mixture of Graff and Maculla[8] has been found most satisfactory for the liberation of adenine, and with prolonged hydrolysis a large part of the pyrimidine bases is liberated. The accompanying reproduction is from a photograph of a chromatogram of turnip yellow mosaic virus nucleic acid hydrolysed in this manner, showing the four bases which are also found in yeast nucleic acid.

It is possible to apply this method to the investigation of the kinetics of reactions such as the hydrolysis of nucleic acids, spots corresponding with the various products appearing and disappearing with time. Other absorbing substances, notably tryptophan, may, of course, be detected by this technique.

A fuller account of this work will appear elsewhere.

We should like to record our appreciation to Dr. Kenneth M. Smith, for his interest and encouragement, and to Dr. J. Davoll and Dr. T. Mann, for the gift of several nucleosides.

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Dec. 23.

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Genic Differences and Rate of Growth in Yeasts

A BREWERY diploid strain of yeast kept under constant observation for the past two years showed a seasonal variation in the characteristics of its giant colonies. On the basis of normal[1] and induced reverse mutations[2], it was surmised that different mutants get established during the various seasons of the year, and hence strains having diverse genic constitutions should differ not only in their viability but also in their growth-rate under particular environmental conditions. It was shown in a previous contribution[3] that the growth-curves of the diploid and autotetraploid are widely different. Since strains having different genic constitutions were available in this Laboratory, it was considered that a study of the growth-rates of two strains assumed to be homo- and heterozygous for the *rough* allele would be interesting.

The strain *BY* 4 was isolated from an active wort culture of the control (*BY* 1) kept in a cold room for ninety days[4]. In February 1947 its giant colony had radiate folds as illustrated in Fig. 1 (1). This strain also showed a cyclical change in its characteristics, and in September 1947 the entire surface of its

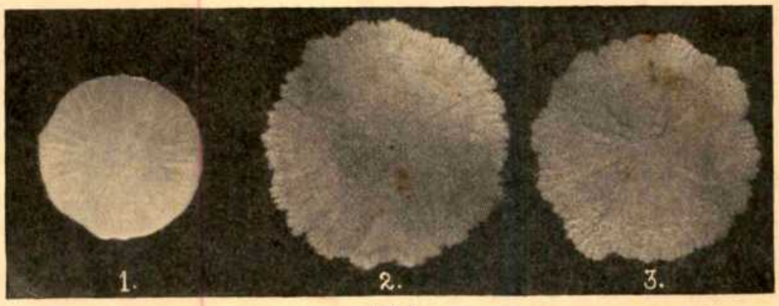

Fig. 1

BY 4. 3·6 cm. 18 days growth (Feb. 28, 1947).

BY 4. 2·8 cm. 14 days growth (Sept. 30, 1947).

BY 1. 3·1 cm. 16 days growth (Nov. 3, 1947)

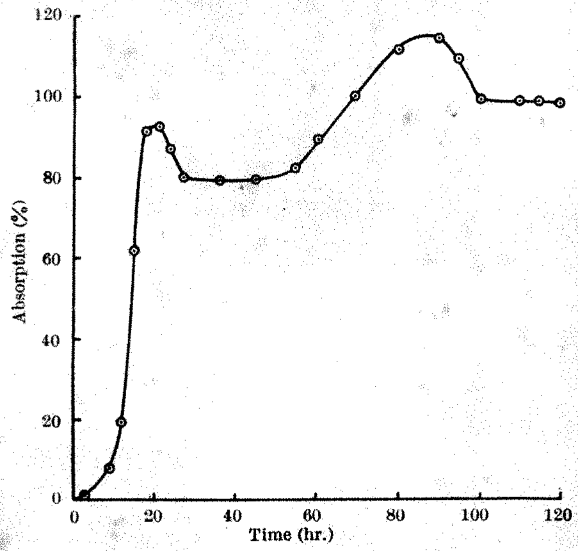

Fig. 2. Growth curve of *BY* 1

colony had a rough sculpturing (Fig. 1 (2)). During the same period the rough sculpturing was limited to the outer half of the colony in the control culture (Fig. 1 (3)). From the later orderly stages of reversion to the smooth type of colony observed in both the strains, it was assumed[4] that while the strain *BY* 4 was homozygous, the control was heterozygous for the *rough* allele.

The investigations on the growth-rates were carried out in the months of August and September 1947. The growth of yeast inoculated into 5 ml. of a standard all-vitamin synthetic medium[6] in 100-ml. conical flasks and incubated at 28° C. was measured at definite intervals using a Lumetron turbidometer. The turbidity obtained at the end of 120 hours was adjusted in each case to read 100 in the turbidometer, and the other readings were taken in terms of this standard.

While the general nature of the two growth-curves are similar (Figs. 2 and 3), the differences between the two strains are shown in the accompanying table.

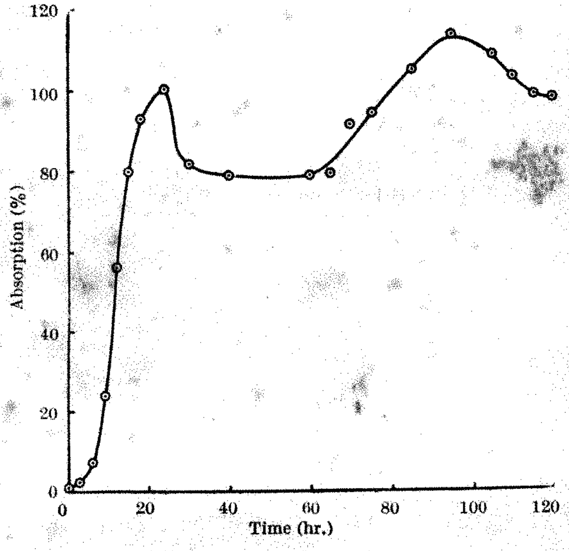

Fig. 3. Growth curve of *BY* 4

	BY 1	*BY* 4
1. End of lag phase reached in	9 hr.	6 hr.
2. End of logarithmic phase reached in	21 hr.	24 hr.
3. Fall in curve	Until 33 hr.	Until 33 hr.
4. Secondary rise commenced at	50 hr.	65 hr.
5. Secondary maximum reached at	85 hr.	95 hr.

Dodge, Dodge and Johnson[7] observe "that there is a definite cycle of fluctuations in the physiology of the cultures". They further state : "Reappearance of very high dry weights (over 90 mgm. under our standard conditions) in approximately six-month periods suggests this as an approximation for the cycle of our stock culture" (pp. 24–25). It would be seen, however, that their explanation that "each culture behaves as liquid tissue of an individual with physiological as well as morphological differentiation of cells" is questionable in view of the explanations now offered.

A perusal of the curves would indicate that the rate of growth of *BY* 4 is slower. Hence it is likely to get gradually eliminated, if by mutation a type heterozygous for the *rough* allele originates in the active culture. Such differential viability and growth-rates of the mutants may explain the establishment of particular types (cf. Braun[8]) when grown at laboratory temperature during the different seasons of the year. It naturally follows that growth of various types of mutants ought to be different during the changing seasons of the year. Wide variations may occur between the relative growth-rates of two strains in two different seasons.

Any investigation of growth-rates of different strains would, therefore, become intelligible only if their genic constitution and variations in the same are known.

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Growth and Development of 'Mung' (*Phaseolus radiatus* Linn.)

The effect of different times of sowing throughout the year on the growth and development of two varieties of 'mung' (*Phaseolus radiatus* Linn.)—Sona mung and I.P.28—sown in pots has been described fully in a recent paper[1]. In this note the effect of different times of sowing on the growth and development of mung sown in replicated small plots in the field will be discussed very briefly; details will be published later.

The final observations and measurements at the fruiting stage of the plants are given in the accompanying table, each figure representing the mean of twelve plants selected at random from each of the plots.

	Sona mung				I.P. 28			
Dates of sowing	Height (cm.) (*a*)	No. of nodes (*b*)	*a*/*b* (*c*)	Days for budding (*d*)*	(*a*)	(*b*)	(*c*)	(*d*)*
Aug. 15	47·6	16·6	2·9	64·6	19·2	6·6	2·9	35·0
Sept. 14	25·2	11·3	2·2	46·0	16·5	6·3	2·6	43·3
Sept. 29	13·5	5·6	2·4	35·8	11·6	5·0	2·3	39·1
Oct. 14	14·0	5·0	2·8	29·5	14·0	5·6	2·5	38·3
Oct. 29	10·4	4·5	2·3	28·6	10·3	4·6	2·2	49·6

* Days for budding = mean days required for flower-bud formation as calculated from the date of sowing up to the date when first flower-bud was just visible.

The results show that there is a correlation between the heights and the corresponding numbers of nodes in the case of both varieties, but that between the heights and the corresponding 'days for budding' is found only in the case of Sona mung. There is also a decrease in height in the case of both varieties for September 29 sowing ; but the corresponding decrease in the number of nodes is only observed in the case of I.P.28. Although there is no correlation between the times of sowing and the ratio of the height to the number of nodes, it is of interest to note that the ratio always lies between 2·2 and 2·9, and that it is highest for the August 15 sowing in the case of both varieties. Again, when sowing was delayed until October, both the varieties became almost similar in height and in the number of nodes, and this was only possible due to the rate of decrease in height and in the number of nodes being much more pronounced in Sona mung than in I.P.28.

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Sept. 8.

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In situ Development of Carpospores of *Bonnemaisonia asparagoides*

In their researches on *Bonnemaisonia asparagoides* (Woodw.) C. Ag., J. Feldmann and G. Feldmann[1] describe the germination of the carpospores. After showing amœboid movement, the spores become round and surrounded by a wall. The first division is equatorial and at right angles to the substratum. Other walls parallel to the first are formed, and subsequent divisions lead to the formation of a hemispherical cushion of cells from the edge of which radiating filaments ultimately develop. This account agrees with the earlier published descriptions given by Kylin[2,3] and Chemin[4], and also Golenkin[5], who recorded some variation in the position of the first wall.

During an examination of *B. asparagoides* (collected from the Tan Buoy, Millport, Cumbrae, in 1928) germinating spores were observed in three cystocarps. Some of the sporelings were free in the hollow of the cystocarp while others were still attached to the placenta (Fig. 1). The method of germination of these spores is clearly somewhat at variance with the accounts given by the authors cited above (Fig. 2). In the first place, each carpospore has germinated within the sporangium, many of the sporelings being pear-shaped and thus having the same shape as mature spores. They cannot, therefore, have shown any amœboid movement. The most notable features of the sporelings, however, are the conspicuous apical cell (Fig. 2) and the method of germination, which resembles the bipolar type found in the Ceramiales.

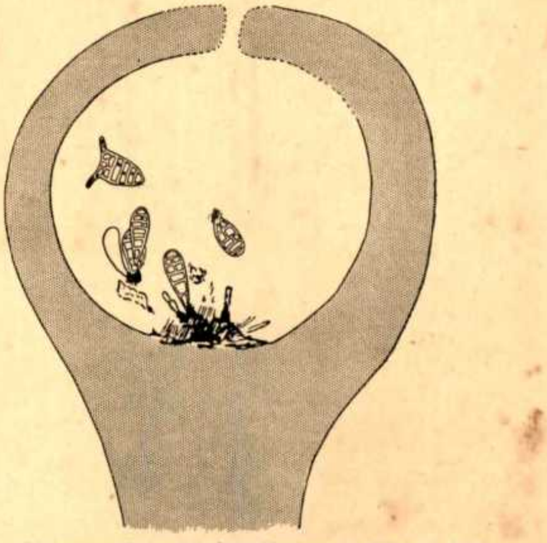

Fig. 1. Diagrammatic tracing from photograph of spores germinating in cystocarp of *Bonnemaisonia asparagoides*. (× 50)

Our knowledge of the life-history in this and related species, as well as of neighbouring genera, is very inadequate and incomplete, particularly with regard to the phase between the liberation of the carpospores and the re-appearance of the gametophyte. Further investigations, the need for which is indicated by these new observations on germinating carpospores, might have as their main objects : (*a*) the elimination of the apparent contradictions in existing accounts of the life-history of *B. asparagoides*, for example, whether under some conditions the gametophyte arises from a special branch of the filamentous growth[3] as well as from the tetraspores[1], and if under other conditions it may arise directly from the carpospore, as is perhaps suggested by the figures published here ; (*b*) to ascertain whether the tetrasporangia, which are said[1,6] to develop on the filamentous growth originating from the carpospores, are homologous with the tetrasporangia of the Ceramiales or simply accessory reproductive spores possibly on occasions reproducing the filamentous growth ; and (*c*) the effect of seasonal factors on morphological development.

In view of the rather ephemeral nature of *B. asparagoides* and its deep-water habitat, it may well be that further investigations of *Batrachospermum* under controlled conditions of culture may be the

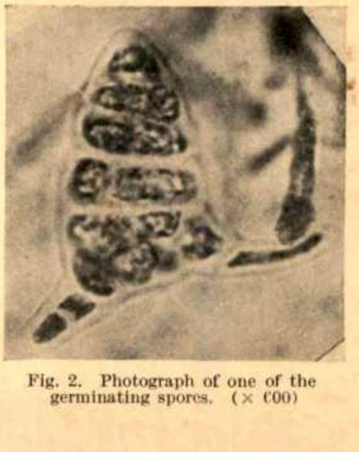

Fig. 2. Photograph of one of the germinating spores. (× 600)

means of elucidating obscure points in the development of those Nemalionales which possess simple filamentous stages.

The Feldmanns[1] have suggested that the microscopic stage of *B. asparagoides* is a tetrasporophyte, and that the life-history might be regarded as occupying an intermediate position between the *Nemalion* and *Polysiphonia* types. While this seems unlikely, both on general grounds and because of the great dissimilarity of the two phases, it is possible that *Bonnemaisonia* may represent an elaboration of the *Nemalion* type along another line of development. The importance of this question indicates how desirable are further investigations.

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Jan. 12.

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Posterior Lobe of the Pituitary Gland and the Metabolism of Lipides

THE acetone extract from posterior pituitary lobes of cattle includes a number of substances of special interest. One of these substances decreases the growth-rate of young animals, plant seedlings and transplantable mouse carcinoma[1-3]. Another substance when injected into white mice of practically cancer-free strain causes the appearance of malignant tumours in about 25 per cent of the animals treated[4].

Further investigations have shown that the extract includes a substance which, when injected into rabbit or dog, lowers the amount of cholesterol present in the blood serum[5]. The decrease affected free, as well as esterified, cholesterol.

An acetone extract of posterior pituitary lobes of cattle when successively treated with ethyl ether, ethanol, petroleum ether and methanol yields also another fraction which, after subcutaneous injection into the dog, increases the amount of cholesterol present in the blood serum of the treated animal. Two other fractions were also obtained from the acetone extract, one of which decreases the serum phospholipide content, and the second of which increases the serum lipide content in the dog.

Of the more than a hundred experiments performed we quote some typical protocols. Healthy dogs of about 8 kgm. weight were used in the experiments. Cholesterol was measured by the method of Schoenheimer and Sperry[6], phospholipides by the method of Youngburg and Youngburg[7]. The serum lipide values in mgm. per cent are given prior to, and three hours after, subcutaneous injection of the particular fractions.

I. Dog *AC*, injected with 12 mgm. of fraction *A*

Cholesterol :			
total :	before, 132·0 ;	after, 106·0 ;	decrease, 19·8 per cent
free :	,, 40·0 ;	,, 36·0 ;	,, 10·0 ,,
esters :	,, 92·0 ;	,, 70·0 ;	,, 23·9 ,,
Phospholipides :	,, 17·0 ;	,, 14·8 ;	,, 12·9 ,,

II. Dog *BX*, injected with 1·4 mgm. of fraction *B*

Cholesterol :			
total :	before, 170·0 ;	after, 214·0 ;	increase 25·8 per cent
free :	,, 44·0 ;	,, 64·0 ;	,, 45·5 ,,
esters :	,, 126·0 ;	,, 150·0 ;	,, 19·1 ,,
Phospholipides :	,, 28·5 ;	,, 28·5 ;	no change

III. Dog *M*, injected with 15 mgm. of fraction *C*

Cholesterol :			
total :	before, 150·0 ;	after, 160·0 ;	increase, 6·7 per cent
Phospholipides :	,, 23·68 ;	,, 19·68 ;	decrease 16·9 ,,

IV. Dog *S*, injected with 10 mgm. of fraction *D*

Cholesterol :			
total :	before, 186·0 ;	after, 182·0 ;	decrease, 2·2 per cent
Phospholipides :	,, 13·2 ;	,, 16·7 ;	increase, 26·6 ,,

The chromatographic separation of the cholesterol-depressing fraction *A* yielded even more interesting results. The cholesterol-depressing effect is due to three different substances, one of which lowers only the ester-cholesterol content of the serum, while the second substance lowers free cholesterol, and the third substance lowers esterified and free cholesterol both at the same rate. The action of these substances is especially manifest 24 hours after the subcutaneous injection.

We enclose typical experimental protocols giving the serum lipide values in mgm. per cent prior to, and 24 hours after, the injection of the particular fractions :

V. Dog *BH*, injected with 1·0 mgm. of fraction 33*E*

Cholesterol :			
total :	before, 108·0 ;	after, 72·0 ;	decrease, 33·3 per cent
free :	,, 28·5 ;	,, 28·5 ;	no change
esters :	,, 79·5 ;	,, 43·5 ;	decrease, 75·4 ,,
Phospholipides :	,, 20·68 ;	,, 20·32 ;	,, 1·7 ,,

VI. Dog *BN*, injected with 12 mgm. of fraction 3*EN*2

Cholesterol :			
total :	before, 130·0 ;	after, 114·5 ;	decrease, 11·9 per cent
free :	,, 46·0 ;	,, 31·6 ;	,, 31·4 ,,
esters :	,, 84·0 ;	,, 82·9 ;	,, 1·3 ,,
Phospholipides :	,, 24·5 ;	,, 24·5 ;	no change

VII. Dog *BQ*, injected with 10 mgm. of fraction 3*BE*

Cholesterol :			
total :	before, 167·0 ;	after, 100·0 ;	decrease, 40·0 per cent
free :	,, 52·0 ;	,, 30·0 ;	,, 42·3 ,,
esters :	,, 115·0 ;	,, 70·0 ;	,, 39·2 ,,
Phospholipides :	,, 24·1 ;	,, 23·5 ;	,, 2·5 ,,

Investigations are in progress aiming at the isolation of the active substances in a pure state.

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'Lewis' Blood-Group System

WHILE our first communication describing the Ken antigen was in the press[1], R. R. Race informed us of the discovery by Andresen of irregular agglutinins anti-L_1 and anti-L_2 [2,3], the latter giving reactions very similar to our anti-Ken serum. Andresen recognized that the L_1 character was, in fact, the 'Lewis' blood-group described by Mourant[4].

On the other hand, the anti-L_2, as our anti-Ken, gave a higher proportion of positive reactions with *O* bloods. But Andresen pointed out that the defect in positive reactions was found in the A_1 group only, while the A_2 group behaved as the *O* group. He explains the difference by an epistatic action of the property A_1 (or the gene p_1) on the development of the property L_2.

This explanation does not seem probable, in the light of the action of blood-group substances on both anti-Ken and anti-L_2 sera[5]; essentially, the addition of Witebsky's substances to anti-Ken serum and of Morgan's purified A-group substance to anti-L_2 removes the difference in the distribution of positive and negative reactions observed among O- and A-cell groups when unabsorbed serum is used.

It seems, then, more reasonable to postulate a serological explanation of the difference observed when unabsorbed serum is used: anti-Ken and anti-L_2 would contain two antibodies, one of which accounts for the agglutination of 50 per cent of bloods in all A- and O-groups, and the other capable of uniting with the A_1 receptor (as it possesses a definite affinity for the A blood-group substance) without giving any agglutination but being diverted from its specific receptor responsible for the agglutination of 'the surplus' in O- and A_2-groups.

Suitable absorption experiments should solve this problem and verify the value of our hypothesis.

We have studied a few families, and we have found that whenever Ken was absent in both parents, it could not be found in the children. On the contrary, some Ken + parents had in certain cases Ken − and Ken + children. It would appear, therefore, that Ken is dominant over its absence. This point can only be established when the exact number of agglutinins in anti-Ken serum is known.

Finally, we wish to lay stress on the possibility of immunization against the antigens of the 'Lewis' group system.

If Mourant's anti-Lewis and Andresen's anti-L_1 and L_2 sera behave like 'natural' irregular iso-agglutinins, anti-Ken was definitely of immune origin and gave rise to hæmolytic disease of the newborn.

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Colour Discrimination in the Dronefly, *Eristalis tenax*

DIFFERENTIAL reactions to various wave-lengths or wave-length bands, independent of intensity, have been claimed for several members of the group of Diptera[1-4]. None of the authors concerned, however, had based his experiments on the training method which, when applied to honey-bees, had yielded more detailed and exhaustive results than any other method[5,6]. It may therefore be of interest that a solitary insect belonging to the group of Diptera has been trained to colours successfully for the first time, in preliminary experiments carried out in this Department.

A number of droneflies, mostly *Eristalis tenax*, caught feeding on yellow flowers, were trained to find their food (sugar-water) on flower models made of coloured papers, offered in a greenhouse. The papers belonged to the Ostwald standard series which consists of twenty-four different hues; each hue, denoted by a figure (1 to 24), is available in different shades of lightness and saturation, indicated by letters following the numbers. *Eristalis* quickly learned to find their food on models cut out of the training colour Ostwald yellow 2 *na*, the letters *na* indicating the most saturated shade.

In order to find out whether the insects recognized the specific wave-length band reflected by the yellow paper, or its special degree of lightness, which need not be the same for the insect's eye as for our own, the following arrangement was offered, without any food, in the first series of test experiments: models not only in the training colour, but also in two other shades of the same yellow hue, were presented, together with models in various steps of grey, ranging from black to white, of the Ostwald grey series. We have to make the assumption that these grey papers appear neutral or near neutral also to the insect's eye, at least when illuminated by full sunlight, which was guaranteed by a large 'Perspex' window let into the south wall of the greenhouse. If the flies had selected the training colour for its particular degree of lightness, they would either have confused it with one of the grey steps, or they would have selected only one of the yellow shades.

The accompanying table, from which the wide variation in lightness value for man (reflectance) among the yellow shades is apparent, shows the results in raw figures; the proportion of coloured models to neutral ones was one in five.

Test experiment 1, 1–3. Ostwald yellow No. 2, in three shades of lightness, among various steps of Ostwald grey

	Shade	Reflectance	Visits on colour	Visits on all grey steps
(1)	Yellow 2 *ia*	0·55	29	3
(2)	Yellow 2 *na*	0·50	49	1
(3)	Yellow 2 *ne*	0·21	27	7

The selection of each of the three different shades of the same yellow hue from among all grey steps excludes the possibility that the insects were trained to one degree of lightness; they must have recognized the training colour, as well as the two other shades of yellow No. 2, by the specific wave-length region reflected. (Any influence of a smell that might be inherent in the yellow papers had been ruled out in control experiments where the whole arrangement had been covered with a 'Perspex' plate.) Accordingly, the results of the first set of tests prove the existence of colour discrimination in the dronefly.

In another set, consisting of two test experiments, models in the training colour were offered side by side with models in other colours also belonging to the saturated Ostwald *na* papers; the total number of visits was 120. The training colour No. 2 was definitely preferred to red, green, blue and violet, that is, coloured papers reflecting wave-length bands fairly different from its own; it was preferred, to a *lesser* extent, to those colours nearer to it in the Ostwald series, namely, No. 24 and No. 1 (greenish-yellow) and No. 3 and No. 4 (orange), which reflect wave-length bands similar, or adjacent, to those reflected by yellow 2, whereas their lightness values vary over a wide range.

In a third set of tests, four shades of lightness of yellow No. 2 (2 *na*, *ne*, *ia* and *ie*) were offered, together with four different shades of lightness of blue 14 (*na*, *ne*, *ia*, *ea*). The yellow shades received a total of 47 visits as compared with a total of only 3 visits on the blue shades. These results make it probable that, in the same way as the discrimination between yellow and grey, the discrimination between yellow and various other colours, particularly between yellow and blue, is also due to differences in wave-length bands reflected, independent of differences in degree of lightness.

A spontaneous feeding response to various colours, with a high peak in yellow, has been shown to exist in the butterfly *Vanessa polychloros*[7]. Without using insects bred from pupæ, it cannot be decided whether the results mentioned thus far could not perhaps have been caused by a similar inborn response to yellow in *Eristalis*. However, this explanation does not hold good for the results obtained after an attempt to train the insects to blue, which unfortunately could not be completed owing to the end of the season. In a last series of tests carried out with *Eristalis* fed on blue 14 *na* for several days, blue shades which had been practically neglected in previous tests received at least as many visits as yellow shades (total number of visits on coloured models, 69). This proves that a certain amount of training must have been involved. Thus there is every reason to hope that *Eristalis* may prove a very suitable object for a systematic study of its colour discrimination which it is intended to carry out in this Department during next spring.

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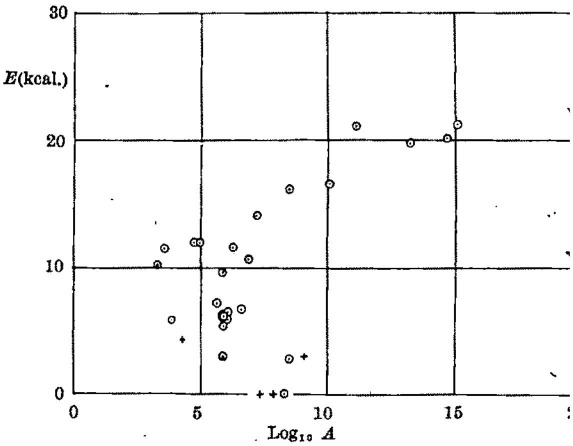
Frequency Factors in Radical Reactions

THE frequency factors and activation energies for reactions in the polymerization of styrene and vinyl acetate have been determined in these Laboratories[1]. By combining the values for chain propagation with the results of Lewis, Mayo, Walling and their collaborators[2], activation energies and frequency factors can be calculated for a number of transfer and propagation reactions of the styryl radical. The accompanying diagram is a plot of E against $\log_{10} A$ for the twenty-nine reactions. It will be seen that the frequency factors are in general low, the mean value of $\log_{10} A$ being 7·4, instead of the normal value *c*. 12. As Gregg and Mayo[2] point out, there is, however, a tendency for reactions with high activation energies to have higher frequency factors.

Attention has often been directed to the fact that frequency factors in polymerization reactions are usually low, but this has been ascribed to steric effects in the reactions of large molecules. However, any size effect should be most marked in the termination reaction in a polymerization, whereas, in the cases quoted, the latter has the highest frequency factor.

The values reported above for the autoxidation of tetralin are also plotted (crosses in the diagram). The mean value of $\log_{10} A$ for the four reactions is



7·1, in good agreement with the mean for the pol merizations. Here no size effect would be anticipate

It seems reasonable to infer that organic radic reactions with activation energies less than abo 20 kcal. in general have frequency factors of the ord of 10^7, and not 10^{12} as is commonly assumed. Steaci has tentatively suggested that this is also true in g reactions.

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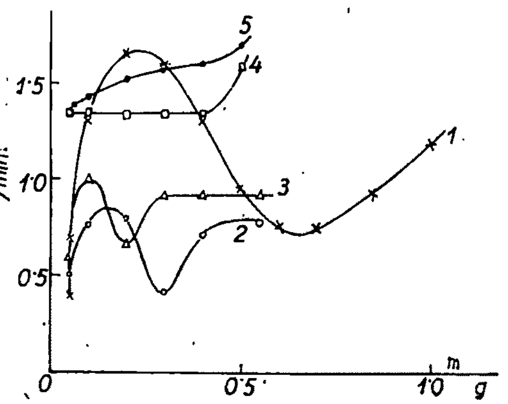
Rate of Hydrogenation in Solutions and the Mass of the Catalyst

IN order to clear up the remarkable relation betwe the rate of hydrogenation and the mass of t catalyst, found by Kailan and Hartel[1], as well as Csürös and co-workers[2], we made a systematic i vestigation on the hydrogenation of crotonic acid a sodium cinnamate in aqueous solutions in conta with hydrogen gas in the presence of palladium pr cipitated on finely dispersed barium sulphate. was found that the product of the hydrogenati (namely, butyric acid in the experiments wi crotonic acid) accelerates the reaction autocatalyti ally.

The initial rate of hydrogenation (v) as a functi of the mass of catalyst (m) has, in pure aqueo solutions, in agreement with the authors above me tioned, a maximum and a minimum (see graph). W found that the value of v and the shape of the cur $v = f(m)$ is greatly influenced by the velocity stirring, the ratio r of the surface to the volume the solution, and the nature of the electrolyt present in the solution. If the velocity of stirring moderate (magnetic stirrer moving in a circle 3 times per minute) and r being small (1–3·4 cm.^{2}/cm.^{3} the curve $v = f(m)$ has a maximum and minimu



Rate of hydrogenation of a 0·13 mol. sodium cinnamate solution (in n cm.^{3} consumed hydrogen per minute). Curve 1, sodium cinnamate alone ($r = 2{\cdot}4$); curve 2, with an addition of 0·033 mol. ammonium chloride ($r = 3{\cdot}4$); curve 3, the same ($r = 2{\cdot}7$); curve 4, the same ($r = 1{\cdot}6$); curve 5, the same ($r = 1{\cdot}0$)

If, on the other hand, the solution is vigorously shaken, the rate of the hydrogenation increases proportionally with the mass of the catalyst.

The shape of the curve $v = f(m)$ is different in the presence of ammonium salts in the solution, showing, in appropriate circumstances, neither maximum nor minimum, even if the stirring is not rapid. The shape of the curve is greatly influenced by r. Varying r, v can be made independent of m; moreover, the maximum can also re-appear (see graph). The ions Na^+, H^+ and Cl^- have no such influence. It should be mentioned that the electrokinetic potential of the catalyst is essentially influenced by ammonium ions, suggesting that the alteration of the $v = f(m)$ curve is—partly at least—caused by this factor. The experimental results suggest the following explanation.

The fraction of the catalyst on the surface of the solution and near it has a greater catalytic action than the fraction in the solution. This behaviour can be correlated with various factors, one of which is the fact that the catalyst near the surface of the solution, which is in almost direct contact with the hydrogen gas, contains more adsorbed hydrogen than that in the solution, the rate of the hydrogenation being, *ceteris paribus*, undoubtedly proportional to the concentration of hydrogen per unit area of the surface of catalyst. Within the solution, the concentration of hydrogen is under stationary conditions lower than in equilibrium, having regard to the point that the reaction is consuming a certain amount of hydrogen, the support of which by diffusion and convection is rather slow.

The increase of mass of the catalyst has various effects on the rate of the reaction. On one hand, the quantity of the catalyst near the surface of the solution will be increased, accelerating the reaction, although the velocity of stirring, the pressure of hydrogen and surface area of solution are kept constant. The increased rate of hydrogenation near the surface diminishes, on the other hand, the diffusion of the hydrogen in the solution, since a greater part of the hydrogen dissolved per second from the gas will be consumed near the surface than in such experiments in which we are applying a smaller amount of catalyst, and only a smaller part of the hydrogen can be transferred into the solution. The concentration of the hydrogen is consequently diminished in the solution, and the adsorbed quantity per unit area of the catalyst diminishes also, all the more so as the whole area of the catalyst is increased.

The effect in the solution is twofold: on one hand, the increase of the whole area of the catalyst is accelerating the reaction; on the other, the decrease of the adsorbed amount of hydrogen per unit area of the catalyst is retarding it. It depends on the experimental conditions which of these two effects is to prevail. The rate of the reaction in the solution can therefore be diminished or increased by increasing the quantity of the catalyst. A more detailed development of this consideration shows that the shape of the theoretical curve $v = f(m)$ is, under adequate conditions, similar to that of the experimental curves. Further investigations on the quantitative agreement are in progress.

Fuller details of the above-mentioned experiments and considerations, carried out in collaboration with J. Szabó, will be published elsewhere.

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Sun-bathing by Birds and its Anti-rachitic Value

In the issue of *Nature* of November 27, p. 843, there is a note on the subject of sun-bathing by birds, quoting *British Birds* as saying that the question has been raised "whether irradiation of the skin with its consequent effect of vitamin D production would take place through sun-bathing".

In this connexion I should like to direct attention to the publications by Hou[1,2] in 1930 on this subject. Hou found by feeding tests that the skin and feathers of fowls exposed to the sun in the usual way were anti-rachitic, but that if the birds' preen glands were removed, and vitamin D excluded from their diet, they developed rickets.

From these results we can reasonably assume that one of the functions of preening is to enable the bird to secure and swallow irradiated preen gland oil, which suggests that direct irradiation of the skin is not necessary for birds to keep them free from rickets.

It seems highly probable that, in the case of mammals which have a thick enough coat of hair or fur to prevent direct access of sunlight to the skin, the sebaceous secretion which lubricates the hair contains antecedents which are converted into vitamin D by irradiation. The elaborate toilet of the fur by such animals would therefore be comparable physiologically with preening by birds. According to Hou and Tso[3], human sebum is anti-rachitic, and Hou found that if rabbits' ears were washed with ether, irradiation of the ears by a mercury vapour lamp could not cure rickets induced in the animal, but that it could if the fatty substances were not removed.

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DERIVATIVES OF *CENTELLA ASIATICA* USED AGAINST LEPROSY

Chemical Constitution of Asiaticoside

CENTELLA asiatica (Urban) (*Hydrocotyle asiatica* L.) is a plant of the family Umbelliferæ. Infusions of this plant are utilized in India and Madagascar against leprosy; it is also mentioned in the French Pharmacopœia of 1884.

Bontems[1] reported in 1942 the isolation from *Centella asiatica* of a crystalline glycoside which he called asiaticoside. Devanne and Razafimahéry[2] proposed the formula $C_{21}H_{34}O_8$ for this glycoside, and stated that hydrolysis gives one molecule of glucose and an amorphous aglucone $C_{15}H_{24}O_3$.

We have recently begun a study of the chemical constitution of asiaticoside, using crystalline material produced on a pilot-plant scale in Tananarive (Madagascar)[3]. After three recrystallizations from dilute alcohol we obtained colourless prisms, m.p. 230–233° (decomp.), $[\alpha]_D = -14°$ (in alcohol). Elementary analysis and the composition of the products of hydrolysis are in agreement with the formula $C_{54}H_{90}O_{23}$, or $C_{54}H_{88}O_{23}$ for asiaticoside (found: C, 58·18, 58·38; H, 8·32, 8·25; calculated for $C_{54}H_{90}O_{23}$: C, 58·54; H, 8·21 per cent).

Acid or alkaline hydrolysis of asiaticoside proceeds remarkably rapidly and gives an aglycone and two different sugars. These have been identified as glucose and rhamnose, by preparation of crystalline derivatives, and by partition chromatography on paper[4]. A quantitative determination of rhamnose by the method of Nicolet and Shinn[5] indicates the presence of two molecules of rhamnose for one molecule of asiaticoside (found, 28·98 per cent rhamnose; calculated, 29·63 per cent). The optical rotation of the sugar mixture formed by hydrolysis and the reducing power as determined by the method of Bertrand[6] show that asiaticoside contains two molecules of D-glucose and two molecules of L-rhamnose.

The aglycone of asiaticoside is a triterpene acid, $C_{30}H_{48}O_5$ or $C_{30}H_{50}O_5$, which we propose to call 'asiatic acid'. The hydrolysis of asiaticoside thus proceeds as shown by the following equation:

$$C_{54}H_{90}O_{23} + 4\,H_2O = C_{30}H_{50}O_5 + \underset{\text{glucose}}{2\,C_6H_{12}O_6} + \underset{\text{rhamnose.}}{2\,C_6H_{12}O_5}$$

Free asiatic acid is very difficult to crystallize (m.p. 240–244°, after purification through its sodium salt, m.p. 310°), but its methyl ester, obtained by methylation with diazomethane or dimethyl sulphate, crystallizes readily (needles, m.p. 225° (corr.), $[\alpha]_D = +52°$ (in alcohol) and analyses correctly for $C_{31}H_{50}O_5$ or $C_{31}H_{52}O_5$ (found: C, 73·83, 73·99; H, 10·29, 10·30; OCH_3, 6·14 per cent (Weiler, Oxford); C, 73·71; H, 10·13; OCH_3, 6·35 per cent (Manser, Zurich); $C_{31}H_{50}O_5$ requires C, 74·03; H, 10·05; OCH_3, 6·17 per cent; $C_{31}H_{52}O_5$ requires C, 73·74; H, 10·40; OCH_3, 6·14 per cent). The Zeisel determinations confirm beyond doubt the size of the molecule.

Dehydrogenation of asiatic acid with palladium-charcoal or selenium gives a hydrocarbon, the picrate and styphnate of which show no depression of melting point with the corresponding derivatives of sapotalene (1 : 2 : 7-trimethylnaphthalene), the typical dehydrogenation product of the triterpenes[7]. Typical colour reactions of the triterpenes are also positive[8].

Melting points, optical rotations and chemical and physical behaviour of different derivatives of asiatic acid show great similarity with those of other triterpene acids of the β-amyrin group; thus all evidence is in favour of the hypothesis that the carbon skeleton of asiatic acid is the same as that of β-amyrin (cf. Haworth[9], Ruzicka[7]).

Two of the oxygen atoms of asiatic acid are accounted for by the carboxyl group; the three remaining ones form hydroxyl groups. Two of these are in a 1 : 2-glycol group, as oxidation with lead tetra-acetate proceeds readily at room temperature and gives a substance precipitating with 2 : 4-dinitrophenylhydrazine. The presence of such a 1 : 2-glycol group seems to be a new feature for natural triterpene acids (cf. refs. 10, 11). The composition of crystalline acetates obtained from asiatic methyl ester is still under investigation.

The presence of a double bond in asiatic acid is indicated by the formation of a bromo-lactone, similar to that of oleanolic acid or hederagenin; tetranitromethane gives a slight colour with asiatic acid or its methyl ester.

The methyl ester of asiatic acid is very difficult to saponify, like that of similar triterpene acids containing a tertiary carboxyl group. On treating the methyl ester, m.p. 225°, with 15 per cent hydrochloric acid, it is isomerized to a new ester, m.p. 170°.

By chromatography on alumina of the crude methyl ester, m.p. 225°, we have isolated a small quantity of a dimethyl ester, $C_{32}H_{52}O_5$, m.p. 262° (found: C, 73·71; H, 10·23; OCH_3, 12·3. $C_{32}H_{52}O_5$ requires C, 74·35; H, 10·17; OCH_3, 12·28 per cent).

As asiaticoside is a neutral substance, it seems that the sugars are attached to the carboxyl group; the ease of saponification suggests that all four sugar molecules are attached in this way. Lythgoe and Trippett have made analogous observations with centelloside[10].

A comparison of our substance with those prepared in Cambridge from *Centella asiatica* from Ceylon[10,11] has shown that we have certainly different compounds in hand. We are very glad to state that we are keeping in contact with Dr. Lythgoe for the study of these triterpene acids.

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Triterpene Acids

Shortly after the announcement in Great Britain[1] that *Centella asiatica* contained a glucose derivative which was active in the treatment of leprosy, we commenced an examination of the plant, with the object of studying the chemical constitution and therapeutic properties of the active material. In this note the results of analyses carried out on dried plant tissue of Ceylonese origin are reported. We are deeply indebted to Dr. J. L. Simonsen, director of the Colonial Products Research Council, for his help in making supplies of this material available to us, and for his interest in these investigations.

No sugar derivative of the type of asiaticoside could be detected, but three triterpene acids were isolated in a pure, though amorphous, condition. It seemed that these were very likely related to the amorphous aglycone of asiaticoside, which was described[2] as giving a red colour with sulphuric acid, a reaction known to be general for triterpene derivatives[3].

The major component of our triterpene mixture, for which we propose the name 'centoic acid', was separated as the sparingly soluble potassium salt (long needles), and purified through the brucine salt, which formed plates from alcohol, $[\alpha]_D = -39°$ (pyridine). The free acid, an amorphous powder, $[\alpha]_D = +44°$ (alcohol), gave analytical data which show it to be a monobasic acid, $C_{30}H_{48}O_6$. It appears to be a normal pentacyclic triterpene acid, closely analogous, apart from its higher hydroxyl content, with oleanolic acid. It gave sapotalene on dehydrogenation with selenium. Although resistant to hydrogenation, it contains a double bond, since with tetranitromethane a yellow colour was obtained with some difficulty[4]. Among its derivatives, the following have been obtained analytically pure, although none of them could be crystallized: a methyl ester, $[\alpha]_D = +36°$ (alcohol), which was stable to hot dilute alkalis and acids; a methyl ester triacetate, $[\alpha]_D = +7°$ (alcohol), which contained one free hydroxyl group (Zerewitinoff); a periodate fission product, $C_{30}H_{46}O_6$, $[\alpha]_D = +92°$ (alcohol), requiring for its formation 1 mole of the oxidant; and a bromolactone. Centoic acid, therefore, contains a tertiary carboxyl and four hydroxyl groups, two of which are present in a cyclic 1 : 2-glycol system.

The other two triterpene acids of dried *Centella* tissue have also been shown to contain a tertiary carboxyl group, an inert double bond, and a 1 : 2-glycol system. That present in the larger quantity, for which the name 'centellic acid' is proposed, was separated by taking advantage of the high solubility of its potassium salt. The brucine salt formed pellet-like needle aggregates, $[\alpha]_D = -44°$ (pyridine), from which the free acid was regenerated as an amorphous powder, $[\alpha]_D = +36°$ (alcohol). Analytical and titration results showed it to be a monobasic acid $C_{30}H_{48}O_6$. As well as the molecular features mentioned above, it probably contains two more hydroxyl groups; but the evidence on this point is not yet clear-cut. The third acid was found present only in minor amounts. Unlike the others, it was precipitated from dilute alcohol by lead acetate. After further purification through the potassium salt (long needles), it was obtained as an amorphous powder, $C_{30}H_{48}O_5$, $[\alpha]_D = +38°$ (alcohol).

It was clearly a question of importance to find whether any of the above acids were identical with the aglycone of asiaticoside, and a short time ago we got into touch with Dr. E. Lederer, who is carrying out an investigation of asiaticoside in Paris. We have compared results on our substances, and Dr. Lederer very kindly provided us with samples of asiaticoside and of the crystalline methyl ester of its aglycone, asiatic acid; we wish to take this opportunity of thanking him for his courtesy. He and his colleagues[5] have shown asiatic acid to be a triterpene acid with properties closely analogous to those of our own acids, and with the molecular formula $C_{30}H_{48}O_5$. A direct comparison has been made with our $C_{30}H_{48}O_5$ acid, and has shown that they are not identical, but isomeric compounds.

We intend to keep in touch with Dr. Lederer, and to extend our investigations on these triterpene acids.

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Aug. 24.

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[2] Bontems, J. E., *Bull. Sci. pharmacol.*, **48**, 186 (1941).

[3] "Klein's Handbuch der Pflanzenanalyse", 3 (2), 1103 (Vienna, 1932).

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[5] Boiteau, P., Buzas, A., Lederer, E., and Polonsky, J., see preceding communication.

Centelloside

Specimens of *Centella asiatica* grown in Madagascar have been found to contain asiaticoside[1], which is said to have value in the treatment of leprosy[2]. Lederer, Boiteau and their colleagues[3] have shown that asiaticoside is a rhamnose–glucose derivative of a triterpene acid, asiatic acid ($C_{30}H_{48}O_5$). Elsewhere[4] it has been suggested that there may be an 'oxidized form' of asiaticoside present in the fresh plant, which is more readily soluble in water.

Work carried out in this Laboratory[5] has shown that dried *Centella asiatica* tissue from Ceylon contains no asiaticoside or similar compound, but that there are present two triterpene acids $C_{30}H_{48}O_6$, closely related to asiatic acid, and traces of a third isomeric with it. It seemed likely that these sugar-free triterpenes might originate as a result of enzyme action on one or more sugar derivative present in the fresh plant, and evidence is now presented which supports that view.

When alcoholic extracts of fresh Ceylonese plant tissue were analysed, free triterpene acids were found only in amounts too small to permit identification. In one fraction of the extracts, however, combined triterpene was present in considerable quantity. This fraction was purified extensively, until only small traces of free sugar were present (as shown by paper chromatography), but no crystalline material could be obtained from it. We think, nevertheless, that it consists substantially of a single substance, which contains a triterpene acid in combination with a sugar system. Its chemical properties resemble closely those of asiaticoside, and accordingly we suggest for it the name 'centelloside'.

Centelloside forms a pale yellow neutral gum, extremely soluble in water, much less soluble in anhydrous alcohol. It reduces Fehling's solution on warming. Dilute acids liberate from it reducing sugars and a triterpene acid, which was identified as centellic acid[5] by conversion to the crystalline brucine salt. The sugar solution left after removal of centellic acid from the hydrolysate was investigated using a variety of techniques. Glucose was identified by paper chromatography[6], and as the phenylosatriazole derivative[7]. Qualitative and quantitative[8] application of the Seliwanoff reaction showed the presence of a ketose; the optical rotation of the solution identified this as fructose. Rhamnose, which is a component of asiaticoside, was absent. Estimations of total reducing power, and of formaldehyde produced on oxidation with periodate[9], combined with the previous data, gave for centelloside the composition: centellic acid : glucose : fructose = 1 : 10 : 2 (mol.). Since strict proof of the homogeneity of the preparation is lacking, these figures must be regarded as provisional, but they show that centelloside carries a much larger sugar system than asiaticoside, and to this, and to the fructose content, the hydrophilic nature is probably due.

A property of centelloside which calls for special comment is the behaviour with warm dilute alkali, which rapidly sets free the salt of the aglycone, while destruction of the sugar colours the solution yellow. This high lability to alkali makes it unlikely that any part of the sugar is bound glycosidically to triterpene hydroxyl groups, and is sufficient to account for the action on Fehling's solution without assuming a free reducing centre in the sugar system. The aglycone, centellic acid, has no reducing properties.

The neutral nature of centelloside suggests at once that the linkage between sugar and triterpene is of the ester type. It must be borne in mind, however, that the carboxyl of centellic acid is sterically hindered, like that of oleanolic acid, and the behaviour of two synthetic glucose derivatives of the latter has been found to accord with theoretical expectation, and to diverge from that of centelloside. 1-β-Oleanolyl glucose, m.p. 216–218° (decomp.), $[\alpha]_D = + 46{\cdot}5°$ (alcohol), is hydrolysed by acids, but stable to alkalis. 6-(Acetyloleanolyl) glucose, m.p. 235° (decomp.), $[\alpha]_D = + 81°$ (alcohol), although destroyed by alkalis, is stable to acids. The alkali-lability of centelloside remains unexplained, and clarification is being sought, *inter alia*, by the preparation of centellic esters of different sugars.

It is of interest that the Ceylonese variety of *Centella asiatica* apparently produces no asiaticoside but this closely related compound. Whether this reflects a morphological difference, or merely one of habitat or season, we are not competent to decide.

We are indebted to Dr. J. L. Simonsen, director of the Colonial Products Research Council, and to Dr. R. Child, director of the Coconut Research Scheme, Lunuwila, Ceylon, for making the fresh plant material available to us; the plants were identified botanically at the Department of Agriculture, Peredeniya, Ceylon.

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Aug. 24.

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ELEMENTARY BODIES OF VARICELLA AND HERPES ZOSTER

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DESPITE the prevalence of varicella and herpes zoster, little information is available concerning the infective agents themselves, since susceptible experimental animals providing adequate quantities of the viruses have not been found. Optical microscopical observations on the morphology and size of stained varicella virus have been made by Aragão[1], Paschen[2], Amies[3] and, more recently, by van Rooyen and Illingworth[4]. The last-named workers describe the infective agent as having a diameter of 1,250–1,750 A., and as being appreciably smaller than the elementary bodies of vaccinia and variola. Particles of the size stated are at the limit of resolution of the optical microscope, so little information is available concerning the elementary body itself.

Ruska[5] has reported an electron microscopic study of these viruses in a journal not available to us. Ruska's work was published before the 'shadow-casting' technique of Williams and Wyckoff[6] was devised, but we have used this method in a study of these viruses. The electron microscope used was an R.C.A. Model *EMU*.

The material used was fluid withdrawn from early vesicles in cases of chickenpox and shingles and variously diluted with normal saline to one-fifth to one-twentieth of the original concentration. Approximately 0·01 c.c. of the diluted fluid was allowed to evaporate to dryness on a collodion film stretched across a wire-mesh specimen screen, washed with distilled water to remove soluble salts and then 'shadow-cast' with platinum as recommended by Williams and Backus[7]. A thickness of c. 7 A. of platinum was deposited at such an angle that the shadow-lengths were 3·9 times the heights of the corresponding particles.

In fluid direct from the vesicles of four of the five cases of chickenpox examined, a number of bodies of regular size and shape were seen. The identity of these bodies with the causative agent of varicella was established by making two sets of preparations. The first (*a*) consisted of equal volumes of vesicle fluid diluted one-in-five with normal saline and of serum similarly diluted, taken from a patient 24 hours after the onset of an attack of chickenpox. Set (*b*) was similarly prepared except that the serum used was taken from the same patient on the eighth day of the disease. Both mixtures were allowed to stand for one hour at 22° C. before a portion was transferred to specimen screens and dried. Preparation (*a*) showed a uniform dispersion of particles which occurred singly; by contrast, preparation (*b*) showed considerable aggregation of the particles (Fig. 1).

Only two cases of herpes zoster were available for examination, and the vesicle fluid of one of these was found to contain particles indistinguishable in size

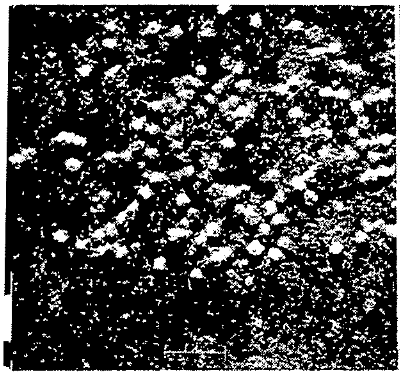

Fig. 1

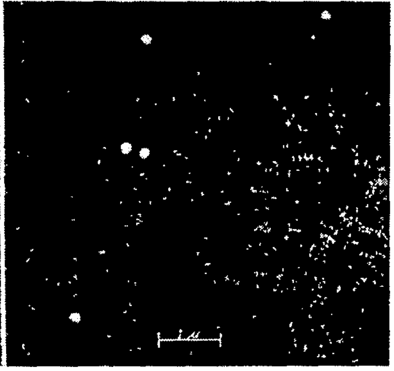

Fig. 2

Fig. 1. Varicella virus agglutinated with convalescent serum. Shadow-cast with platinum. Shadow ratio, 3·9

Fig. 2. Varicella virus fixed with 0·5 per cent osmic acid. Shadow-cast with platinum. Shadow ratio, 3·9

and shape from those observed in varicella. In view of the well-known fact that an attack of either herpes zoster or of varicella affords immunity against the other, attempts to observe agglutination of herpes zoster virus by convalescent serum from a case of varicella were made. Once again the convalescent serum caused much more marked aggregation of the virus than did the onset serum.

The profile of the virus particles shown in the micrographs is roughly circular; but measurements of shadow-lengths (see table) indicate that they are not truly spherical but oblate. In fact, the appearance of the particles is that of caps of ellipsoids, suggesting that the particles have collapsed to various extents on drying at room temperature. Evidence in support of this view was obtained by fixing the particles by the addition of osmic acid or formalin to the virus suspensions in saline. When so fixed, the virus particles approach more closely to the spherical form when dried (Fig. 2). As the micrographs yielded insufficient information for the calculation of the volumes of the unfixed virus particles as caps of ellipsoids, they were treated as caps of spheres and their volumes were found to agree with those of the fixed particles treated as ellipsoids (see table).

	No. of particles measured	Mean diameter (A.)	Mean height (A.)	Mean volume (10^6 A.^{3})
Varicella virus	77	2420±30	730±15	1880±60
Varicella virus and onset serum	30	2420±30	750±30	1950±90
Varicella virus and convalescent serum	45	2450±40	800±20	2150±80
Varicella virus and 5 per cent formalin	14	1860±70	1030±40	1870±160
Varicella virus and 0·5 per cent osmic acid	14	1750±35	1180±50	1890±110
Herpes zoster virus	19	2530±80	790±30	2240±160

Hodge[8], of this Laboratory, has observed a similar effect on fixing influenza virus particles with phosphotungstic acid. Similar observations have been made by Dawson and McFarlane[9] on the brick-shaped particles of vaccinia virus. They found particles dried at room temperature had the same lateral dimensions as freeze-dried particles but were only half the height. Particles fixed with osmic acid had the same volume as the particles dried at room temperature; but all dimensions were 20 per cent less than those of freeze-dried particles. It appears that fixed particles retain their true shape to a greater extent than those dried at room temperature, but freeze-drying is required if the true shape and size are sought.

Statistical treatment shows that the untreated varicella virus particles are significantly smaller than those treated with convalescent serum and are also smaller than herpes zoster virus particles. However, our preparations contained too much extraneous protein material to allow any real significance to be attached to these differences. The mean particle dimensions and their standard errors given in the table depend on magnification calibration obtained by means of interferometrically measured glass fibres as described by Farrant and Hodge[10].

Virus particles treated with phosphotungstic acid and osmic acid show areas of differing densities suggesting internal structure, but no evidence of this could be seen in the unstained particles.

The identity of these bodies with the causative agent of varicella is not conclusively established, as it has not been possible to attempt the reproduction of the disease by purified suspensions of them. It is not, therefore, possible to satisfy Koch's postulates; but the occurrence of the particles in the vesicle fluid of four out of five patients suffering from chickenpox, and the development of serum agglutinins for the bodies observed, during the course of the disease, give a high degree of probability that they are the cause of chickenpox.

Since this work was completed, we have received a paper by Rake and Nagler[11] showing electron micrographs of varicella virus. The particle dimensions in the horizontal plane, given by them, differ from those obtained by us; but it is evident from our own observations that size depends, to a great extent, upon the mode of preparation of the specimen for examination.

We desire to thank Dr. W. Stephenson and Dr. A. Ferris, of the Infectious Diseases Hospital, Fairfield, Melbourne, who kindly supplied the specimens for investigation. We also thank Dr. A. L. G. Rees, of the Division of Industrial Chemistry, for his interest in this work.

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MECHANICAL WEAR

SUMMER CONFERENCE AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A SPECIAL summer conference on mechanical wear was held at the Massachusetts Institute of Technology, Cambridge, Mass., on June 14–16, under the joint sponsorship of the American Society of Mechanical Engineers, the General Motors Corporation and the Chrysler Corporation, together with the Institute itself. The object of the conference was to take stock of the present knowledge and theories on this very important subject so that the most profitable directions of future research might be more clearly indicated. The absence of any general meeting on the subject in either the United States or Europe during recent years made this especially desirable.

The papers presented and accompanying discussion covered laboratory and service experience on wear in internal-combustion engines, steam turbines, brake materials, journal bearings, gears, electric brushes (in the absence of electric currents), surface plates and cutting tools. In addition, results of laboratory tests on laboratory machines simulating some of these service operations and also on specially designed wear-test machines were reported. Specifically excluded from consideration at the conference were the subjects of cavitation erosion by liquids and the wear of current-carrying electric contacts.

It was the general consensus that the wear phenomenon is exceedingly complex and depends on numerous factors. Some of these factors were discussed in considerable detail by one or more of the speakers. They included hardness, fatigue strength, gas adsorption, chemical reaction, and viscosity. These discussions were too long to report here in detail, but the following notes indicate matters which were especially interesting to those present.

F. P. Bowden and D. Tabor (University of Cambridge) summarized the various ways in which rubbing surfaces can operate, depending on the quantity and type of lubricant present (in other words, full-fluid, boundary or dry), and they cited various evidence for presence or absence of metal-to-metal contact in each of the three regions. The evidence showed, on one hand, intermittent contact even under conditions of sliding hydrodynamic lubrication, but on the other hand the transmission through thick oil-films of compressive stresses exceeding the yield point of the metal without direct solid contact. In a separate connexion they showed that fatty acids, which are supposed to attack metal surfaces chemically to form metal soaps which are very effective boundary lubricants, will not attack these same metal surfaces if the latter have not previously been exposed to air and moisture. R. Savage (General Electric Research Laboratory) described his recent findings on the mechanism of the lubrication and wear of graphite. He found that the presence of oxygen or water vapour was necessary for graphite to lubricate in its familiar manner. In the absence of these gases it wears extremely badly, producing a fine dust having strong surface-active properties.

E. S. Starkman and A. G. Cattaneo (Shell Development Company) showed that the corrosive wear of piston rings increased with the amount of sulphur in the fuel, owing to formation of sulphur trioxide; it increased with the amount of tetra-ethyl lead in the fuel owing to the simultaneous presence of the halogen scavenger, and it increased sharply below the dew-point of the water vapour in the combustion gas mixture owing to the formation of carbonic acid. R. Holm (Stackpole Carbon Company) proposed a relation, for the purpose of correlating wear measurements, which involves the hardness of the rubbing surfaces. He also discussed the relation of this contact hardness, as measured by an indenter, to the yield point of the metal. In addition, he showed that the measured contact-hardness depended on the size of the indenter.

H. Blok (Royal Dutch Shell, Delft) showed that the failure of gear teeth under exaggerated impact loading depended much more on the viscosity of the lubricant than on its oiliness or extreme-pressure characteristics. This was attributed to the ability of viscous liquids to withstand suddenly applied compressive loads. J. O. Almen (General Motors Research Laboratories) discussed the wear of gear teeth and especially that type known as scoring or welding wear. He showed a correlation between failure due to this type of wear and the product of the factors of compressive stress, sliding velocity, and the length of time the teeth are in contact. E. Buckingham (Massachusetts Institute of Technology) and G. J. Talbourdet (United Shoe Machinery Corporation) reported data on the failure of gear materials from another type of wear, namely, pitting fatigue.

J. H. Dedrick (University of Cincinnati) and John Wulff (Massachusetts Institute of Technology) described friction and wear measurements on certain ternary-bronze powder-metallurgy brake-materials containing lead, graphite and silica. They found that only a small region on the corresponding ternary diagram gave alloys having suitable characteristics as regards wear-rate and quiet operation. This area is limited to compositions containing both lead and graphite, but silica is not necessary. R. G. Larsen (Shell Development Company) tabulated and discussed all the possible adsorption and chemical reactions that could take place between the rubbing metal surface and its gas or lubricant environment. These were found to be quite numerous and sometimes complex. C. M. Allen (Battelle Memorial Institute) reported qualitative information on the minimum oil-film thickness in a fluid-lubricated journal-bearing just prior to failure. He measured the electric break-down potential of the oil film and showed that this often gave warning of impending failure.

The complete proceedings of the conference will be published shortly by the American Society for Metals, Cleveland, Ohio. J. T. BURWELL, JUN.

ORIGIN OF THE SOLAR SYSTEM

PROF. HAROLD JEFFREYS has published a paper in which he examines a number of theories proposed to explain the origin of the solar system[1]. In the early part of the paper he points out that the resonance theory of the origin of the moon can no longer be maintained; and, in fact, it was shown many years ago to be quite untenable for various reasons, though it is still referred to in popular works as a possible explanation of the existence of our satellite. Dealing with the origin of the planetary system, he refers to his earlier view of a collision between the visiting star and the sun, which appeared to make some successful quantitative predictions, but which Russell showed to be dynamically unsound. Lyttleton's theory that at the time of the encounter with the visiting star the sun was a double star, and that the encounter was with the companion, seemed to offer a way out of the difficulty. On this theory there was the possibility that the visiting star and the companion would escape from the neighbourhood of the sun, and yet leave a considerable fraction of the ejected matter revolving around the sun. Nevertheless, as Jeffreys shows, in all catastrophic theories there is a fundamental difficulty. In Jeans's tidal theory it was assumed that the elongated filament would be gravitationally unstable and would break up into a number of pieces—a view which is difficult to maintain if the matter ejected from the sun (or its companion) had an initial high temperature. Jeffreys investigated a number of cases nearly twenty years ago and showed the difficulties in the view that the gravitation of the mass could maintain equilibrium, though there was the possibility that adiabatic cooling during expansion would lead to the formation of liquid drops at an early stage, and thus the pressure might be relieved before the velocities became uncontrollable. More recently, Spitzer dealt with the same problem and concluded that during the expansion of cylindrical and ribbon-like filaments these would disappear completely.

Another difficulty arises in connexion with the compositions of the planets; it is interesting to note that the greater densities of the inner planets find a natural explanation if they were originally gaseous, because the greater masses of the outer zones would retain lighter materials, which would be lost by the smaller ones. If bodies of different masses were set free suddenly in a vacuum, we should expect that there would be these differences in composition; if gradual evolution took place, the materials would be mixed and the compositions nearly uniform. Hence the present condition of the inner and outer planets favours a catastrophic theory which, as has just been pointed out, is itself open to very serious objections. At this stage Jeffreys discusses some recent results on possible modes of disruption of rotating bodies, and deals with the question of a disrupted planet giving rise to two or more independent planets, thus accounting for the differences of composition among the inner planets. Originally there might have been one or two bodies which acquired too rapid a rotation for stability as they condensed, but before the development of instability the central cores would have had time to form. Lyttleton suggested that all the planets could be brought into this scheme, and secondary disturbances, like a splash, might be associated with the separation. Some pieces might continue with each of the main bodies, giving rise to satellites, while others might become independent of both bodies, forming the terrestrial planets and the moon. In 1941 Lyttleton showed that a planetary system might be formed by fission without any external disturbance. Starting with a triple star with two very close companions, he showed that if these coalesced the angular momentum would be sufficient to produce fission and make them separate indefinitely. The two parts might both escape from the third body (the sun) while leaving part of the splash to be captured by it. The accretion of interstellar matter would cause the coalescence of the two companions, and, as Jeffreys admits, there is no obvious quantitative objection to this theory except that just referred to, namely, the high initial temperatures of the planets.

Although the existence of small bodies presents a difficulty in all theories, owing to their feeble gravitational pull on their material, and Lyttleton's fission theory of the planets offers some hope of explanation as the fission was supposed to have taken place after liquefaction, there is another possible explanation. A liquid or solid, however small, will grow if immersed in a gas, provided that the density of the gas exceeds the saturation vapour density at the actual temperature. A. L. Parson has dealt with this problem[2], and it seems that even with the present small density of interstellar matter, iron, calcium oxide, magnesium oxide and silicon dioxide are capable of condensing; but water, methane and ammonia would be unlikely to condense near Jupiter and Saturn at the probable densities—about 10^{-15} gm. per c.c. Jeffreys admits that Parson's results answer one of his chief objections to the planetesimal theory that the small bodies would collide and volatilize one another before they could produce any notable effect on the planets. If they did, the vapour would condense again and form new dust, the accretion of the planets proceeding. Hoyle has examined the question of accretion by the planets[3] and finds that it would take place at an increasing rate as the planet became larger; and if a condensation reached the mass of the earth, it would grow rapidly to attain a mass of the order of that of one of the major planets.

Other theories on the formation of the planets and satellites are considered; but Jeffreys is not satisfied with any of the existing theories. Thus he says: "But many notable advances have been made in the last twenty years, and the problem is to decide which of them are relevant to the origin of the solar system".

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 14

INSTITUTION OF THE RUBBER INDUSTRY, MIDLAND SECTION (joint meeting with the BIRMINGHAM SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 7 p.m.—Dr. H. W. Melville, F.R.S.: "The Degradation of High Polymer Substances".

INSTITUTION OF THE RUBBER INDUSTRY, PRESTON SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, and the BRITISH ASSOCIATION OF CHEMISTS at the Victoria and Station Hotel, Preston), at 7 p.m.—Dr. W. J. S. Naunton: "Natural and Synthetic Polymers" (with special reference to Rubber and Synthetic Fibres).

Tuesday, February 15

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (joint meeting with the AGRICULTURAL GROUP of the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Discussion on "The Evaluation of Selective Weedkillers" (to be introduced by Dr. M. A. H. Tincker).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "Types of Distribution in the British Flora". (Further Lectures on February 22, March 1 and March 8.)

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. A. Schweitzer: "Reflexogenic Areas of the Vascular System".* (Further Lectures on February 22, March 1, March 8 and March 15.)

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. T. R. C. Fox: "Technical Education".

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Dr. C. Bondy: "The Colloidal Aspect of Rubber Latices"; Dr. W. H. Bodger: "The Applications of Various Types of Rubber Latex".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The International Organisation of Science". (Speakers: Prof. M. J. Sirks, Prof. F. J. M. Stratton, F.R.S., Dr. Joseph Needham, F.R.S., and others.)

Wednesday, February 16

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Large-scale Vertical Motion in the Atmosphere".

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. Barer: "Reflecting Microscopes—Past, Present and Future".

Royal Institute of Chemistry, London and S.E. Counties Section (at 30 Russell Square, London, W.C.1), at 6.30 p.m.—Dr. G. M. Bennett, F.R.S.: "The Work of the Government Laboratory".

Oil and Colour Chemists' Association, London Section (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. D. V. N. Hardy: "Silicones".

Royal Statistical Society, North-Eastern Group of the Industrial Applications Section (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. E. D. van Rest: "Probability and the Experimenter". (To be repeated on Thursday, February 17, at the William Newton School, Norton, Stockton-on-Tees, at 7.15 p.m.)

Society of Chemical Industry, Plastics Group (joint meeting with the London Section of the Plastics Institute, at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. H. M. Stanley: "Petroleum Hydrocarbons as Raw Materials for the Plastics Industry".

Thursday, February 17

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. Burniston Brown: "The New Philosophy of Science".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Jack Spalding: "Ground Control—Theory and Practice".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. P. Erdös: "An Elementary Proof of the Prime-Number Theorem".

British Glaciological Society (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.15 p.m.—Discussion on "The Origin of Ice Pyramids and Dirt Cones on Glaciers".

Chemical Society, North Wales Section (joint meeting with the University College of North Wales and University of Liverpool Chemical Societies, in the Department of Chemistry, University College of North Wales, Bangor), at 5.30 p.m.—Dr. W. H. J. Vernon: "Corrosion, the Study of Surface Reactions on Metals".

Chemical Society, Sheffield Section (joint meeting with the Sheffield University Chemical Society, in the Chemistry Department Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. W. F. K. Wynne-Jones: "Hydrogen Peroxide as an Ionizing Solvent".

University of London (in the Department of Civil, Mechanical and Chemical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. D. H. Lee: "Foundations with reference to Soil Mechanics and Mining Subsidence".*

British Institution of Radio Engineers, London Section (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 7 p.m.—Discussion on "Electronic Equipment for the Engineer".

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. A. W. Bayes: "The Function of Testing in Production".

Textile Institute, Burnley Branch (at the Mechanics' Institute, Manchester Road, Burnley), at 7.15 p.m.—Mr. A. M. Robertson: "Fibreglass and its Uses".

Chemical Society (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 7.30 p.m.—Prof. Dr. V. Prelog (Zurich): "Recent Developments in the Chemistry of Macrocyclic Compounds".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. A. F. Mahaffy: "The Epidemiology of Yellow Fever in Central Africa".

Friday, February 18

Biochemical Society (at St. Thomas's Hospital Medical School, London, S.E.1), at 2 p.m.—Scientific Papers.

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 2 p.m.—Symposium on "Operational Aspects of Marine Radar".

Association of Applied Biologists (in the large Chemistry Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.15 p.m.—Annual General Meeting; Mr. W. C. Moore: "The Significance of Plant Diseases in Great Britain" (Presidential Address).

Eugenics Society (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Rt. Rev. the Lord Bishop of Birmingham, F.R.S.: "The Mixing of Races and Social Decay" (Galton Lecture).*

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Rotary, Oscillating and Reciprocating Seals" (to be opened by Mr. T. E. Beacham and Mr. F. H. Towler).

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. F. P. Bowden, F.R.S.: "Friction".

Society of Instrument Technology, Midland Section (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. N. F. Astbury: "Some Instruments for Iron Testing".

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Mr. W. J. R. Merren: "The Application of Electronics in Glass Manufacture and Glass Research".

Royal Society of Medicine, Radiology Section (joint meetin with the British Institute of Radiology and the Faculty o Radiologists, at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Discussion on "The Physical, Cytological and Medical Aspects o Protection from Ionizing Radiations with Special Reference to th Use of High Voltage X-Rays and Radio-Isotopes" (to be opened b Sir Ernest Rock Carling, Dr. Katharine Williams and Mr. Marley).

Royal Institution (at 21 Albemarle Street, London, W.1), a 9 p.m.—Prof. Homer A. Thompson: "The Agora of Ancient Athens a Study in Archæological Restoration".

Saturday, February 19

Physical Society (in the Department of Natural Philosophy, The University, Edinburgh), at 10 a.m.—Scientific Papers.

Royal Institute of Chemistry, London and S.E. Countie Section (at the University, Reading), at 3 p.m.—Prof. F. E. Simon F.R.S.: "Experiments on Solid Helium".

APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Lecturer in Biology—The Dean of the Medical College, St Bartholomew's Hospital, West Smithfield, London, E.C.1 (February 21).

Principal Scientific Officer or Senior Scientific Officer for research on problems of heat exchange, Senior Scientific Officers (2) for research on (*a*) fluid mechanics and (*b*) kinematics and mechanisms, a Senior Experimental Officer or Experimental Officer to prepare detailed designs of plant, equipment and apparatus for a new hydraulic machinery research laboratory, and a Senior Experimental Officer (Engineer) for general duties connected with the development of new laboratories including an engineering workshop; in the Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research—The Secretary, Civi Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2388 (February 22).

Principal Scientific Officers and Experimental Officers in the Medical Statistical Department of the Directorate of Hygiene in the War Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2390 (February 22).

Librarian in the Department of the Scientific Adviser to the Army Council at the War Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2396 (February 24).

Lecturer in Mathematics at the Military College of Science, Shrivenham, near Swindon—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.335/48A (February 26).

Veterinary Research Posts (Principal Scientific Officer or Senior Scientific Officer grades, unestablished) at a Ministry of Supply research and development establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (February 26).

Chair of Geology—The Secretary, The University, Birmingham 3 (February 28).

Principal Scientific Officers, Senior Scientific Officers and Scientific Officers (unestablished, with good honours degree or equivalent in mathematics, physics, mechanical or aeronautical engineering), at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.451/48A (February 28).

Senior or Junior Physical Chemists for the British West Indies Sugar Research Scheme—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (February 28).

Leverhulme Research Fellowships—The Secretary, Leverhulme Research Fellowships, 7 Bedford Row, London, W.C.1 (March 1).

Scientific Officer (zoologist) to carry out research on fish and fisheries under the personal supervision of the Director—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (March 1).

Director of the Association, a Deputy Director and Head of the Department of Applied Physics, and a Psychologist, at the Ahmedabad Textile Industries' Association, Ahmedabad—The Office of the High Commissioner for India, Scientific Liaison Officer, India House, Aldwych, London, W.C.2 (March 1).

Lecturer in Educational Psychology—The Registrar, University College, Hull (March 1).

Senior or Junior Physical Chemists at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (March 5).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary of University Court, The University, Glasgow (March 15).

Chair of Philosophy, and Lectureships in Mathematics, Botany and Chemistry, at the University College of the Gold Coast—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (March 19).

Director—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 31).

Biochemist with research experience for research and development work of physico-chemical nature in relation to human plasma products, and a Junior grade for work of an immuno-chemical nature; at the Institute's Elstree laboratories—The Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Physical Chemist—The Secretary, Research Association of British Rubber Manufacturers, 105–7 Lansdowne Road, Croydon, Surrey.

Assistant Chemist at the Courtauld Institute—The Secretary, Middlesex Hospital Medical School, London, W.1.

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ORGANISATION AND MANAGEMENT IN NATIONAL INDUSTRIES

THE general lessons to be learned from the experience of the coal industry under national ownership in Britain are clearly of great importance and wide interest in view of the prominent position in the Government's programme for nationalization of industry. A certain amount of material is already available. Sir Charles Reid contributed a series of important articles to *The Times* last November, and now a useful report, "The Organisation of the Coal Board", by Colonel C. G. Lancaster, has been issued by the Conservative Political Centre. The National Coal Board has prepared a statement on what it describes as the "main recommendations" of the committee set up under the chairmanship of Sir Robert Burrows to investigate the organisation of the Board; the reason given for not publishing the complete report is that it "would not be in the best interests of the industry". This ignores the large section of public opinion which is concerned to observe impartially the results of this great experiment in public ownership, with the view of remedying whatever defects of organisation, equipment or other matter that may be revealed, and of seeing that any further experiments in nationalization should be able to avoid the same mistakes. The decision to withhold full publication consorts ill with a Government policy which has established the British Institute of Management and is pressing for higher standards of management in industry.

It is the general lessons to be drawn from the experience of the coal industry that are so important at the present time; nevertheless, the question of public responsibility and accountability which public ownership implies should not be allowed to go by default.

From what has been disclosed of the recommendations of the Burrows' Committee, it seems clear that the original organisation of the National Coal Board was defective; and that some of its difficulties would have been avoided had a more decentralized structure been adopted at the start and one less calculated to destroy the sense of individual responsibility in an industry which, like many others, has depended on personal energy and enterprise. Even with the most perfect organisation, it will not be easy under public ownership to preserve the sense of individual responsibility which is so important a factor in preventing the rise of costs, the elimination of waste of materials or of man-power. The proposals made by Sir Charles Reid in his articles are designed primarily to provide an organisation which insists on personal responsibility at all levels, so that waste in whatever form can be immediately checked and eliminated. Incidentally, they would make the scientific staff merely advisory to the twenty-six operating bodies which would replace the present eight divisions, with the management of research stations as their major work. As Sir Charles observes, character develops with responsibility, and a man will only give of his best when he has complete charge of his job and is trusted to perform it.

The similarities between the internal and the external criticisms of the organisation of the National Coal Board do not conceal a difference in the emphasis laid on the bearing of organisation on the present state of the industry. The transfer of ownership has not given the output that was expected or is essential, and mechanical improvements have not brought productivity above even the pre-war level. Unsatisfactory output and a high level of absenteeism have, moreover, been accompanied by the marketing of very inferior coal, which may to some extent falsify even the output figures, low as they are.

Differences of opinion may exist as to the exact responsibility of organisation for such weaknesses, and as to the most appropriate measures by which to remove them in the coal industry itself. Nevertheless, there is general agreement that there has been confusion in the working of the Board's policy, faulty liaison, lack of clarity in the 'channel of command', and an absence of full understanding and mutual confidence between the different units of authority and between the different departments. The public interest, therefore, demands that there should be full and public discussion of this problem of the organisation of nationalization in industry in time to prevent the repetition of like mistakes elsewhere. Nor can it be said that this is simply a matter of organisation. It is equally a question of management. Fundamentally, it is a question of how to secure the leadership in industry which will simultaneously ensure efficient production, the loyal and full co-operation of all engaged in it at every level, and a high standard of service to the general public which uses the products of industry.

Much is involved in this question of leadership in a free society. It involves industrial psychology as well as the study of administration. The problem of incentives is not one in which we are content just to study people at work and the relations between them and the situation at work: we must study also the people who work as individual human beings, whether they are managers, technicians, craftsmen, skilled or unskilled labourers. We must also study the society as a whole in which they are working; for its conditions can affect incentives just as strongly as those group relations within the factory on which the investigations at the Western Electric Co. have laid such stress.

There, indeed, we are passing into the wider field of social science, and are concerned with moral and spiritual as well as with material factors. This is one reason why the report of the Present Question Conference at Magdalen College, Oxford, last August on "The Problem of Leadership in a Free Society"* is so timely. Here once again is reiterated the need to take full account of the total social and industrial situation in which the workers in any particular firm or organisation find themselves. Incentives and deterrents, for example, can only be judged against the background of social reality, taking account both of the social setting and of individual attitudes. It is scarcely possible to avoid in modern industry some degree of remote control. The real question is the extent of such control, and how to secure, simultaneously, adaptability and flexibility and the spontaneous co-operation which is vital in efficient production.

The major part of the third Present Question Conference was devoted to a discussion of leadership in industry initiated by Mr. W. B. D. Brown, the other major contributions being those of Prof. D. M. Mackinnon on the leader and the idea, and of Dr. J. H. Oldham on leadership and society. All alike put men and women as persons into the centre of the problem, but stress the need for reconciling the needs of the individual with those of the smaller and larger groups of which the individual is a unit and which permit both the expression of individuality and the growth of units and social groups. Much that Mr. Brown has to say about leadership in industry, particularly on joint consultation and the like, is to be found in other words in Mr. F. J. Burns Morton's recent book "Team-work in Industry"; but he brings out even more clearly the way in which with the passing of autocracy there must be a keener and more widely diffused sense of responsibility among all engaged in industry.

That is the condition of industrial democracy; and Prof. Mackinnon, pursuing much the same theme, shows how this question of freedom in industry is linked up with the idea of service. It is implicit in the idea of leadership; and while both industry and society require leadership of all kinds and at all levels, it is leadership of a type, not indeed unknown or even rare in history, but alien from that in which the idea of domination or autocracy prevails. It is the leadership of which Arthur Bryant wrote in "Years of Victory": not a mere matter of transmitting orders but of evoking the will to serve. It is the quality which, as Dr. Oldham insists, inspires men and women, and secures the constant but spontaneous co-operation of others in raising the standards of society and in the pursuit of excellence. It means leaders who are capable of understanding the common or group mind, and who, while taking account of scientific and technical factors in industrial or social problems, are not dominated by them.

Dr. Oldham's words here need to be weighed by those who are inclined to exaggerate the importance of a scientific approach, and to look to the use of the scientific method alone to solve our social and political problems. Dr. Oldham recognizes our great need of more knowledge especially in the field of the social sciences, and that there are important problems capable of technical solutions; but he insists that fundamental problems of human society to-day are not the technical problems. They are problems of equilibrium between competing interests, the distribution of power and the restraint and responsible exercise of power. They require for solution not knowledge or technique but the wisdom which is the mark of the statesman.

The question of moral and spiritual power arises here, and that involves a question of values—that persons are prior to things. The Present Question Conference is a challenge to the materialism and the false scale of values which have been responsible for so much that is wrong and weak in industry to day. Some of these weaknesses are shown in greater detail by Mr. Burns Morton in the book already referred to. They will not be eliminated altogether by new techniques of co-operation or forms of organisation, but only as some moral or spiritual force takes possession of individuals and groups and binds them together in the same sense of fellowship and service to a great cause as we witnessed in Britain under great leadership in the summer of 1940.

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* Question. Vol. 1, No. 2. Winter, 1948. (Present Question Conference, Ltd.) 2s. 6d.

This is no new conception of leadership. Colonel L. Urwick has brilliantly expounded Mr. Ordway Tead's definition of leadership as winning the will to co-operate from those whose co-operation is needed, and making the purposes of the joint undertaking explicit and continuously attractive to those who share the burden of attaining them. We have still far to before that conception finds adequate expression in industry, whether nationalized or not, and it is a conception that applies to leadership both at the lower levels and at the highest ranks of management. The social scientist and industrial psychologist have undoubtedly still much to contribute in this field and may help us to understand more clearly the causes of past failure and to devise new ways or techniques of overcoming them. But what is needed is not so much new knowledge as the wise and resolute application of much that is already known and even familiar. We need the driving force of a common purpose and a common ideal, and it is in this conviction that Sir Stafford Cripps writes in his foreword to the report of the Present Question Conference: "We can hope for but little from our future unless we are prepared to place behind all our efforts our full spiritual power and force. More and more it is brought home to me in all my work that it is the moral strength of high spiritual standards that must give us the courage and determination to solve our many problems in the social, economic and political fields. Let us not be afraid to proclaim and to act upon the faith that is ours, faith in the power of the spirit of man to control the material resources at his disposal."

LORD RUSSELL'S THEORY OF KNOWLEDGE

Human Knowledge

Its Scope and Limits. By Bertrand Russell. Pp. 538. (London: George Allen and Unwin, Ltd., 1948.) 18*s*. net.

LORD RUSSELL interprets human knowledge narrowly. He deals with scientific knowledge and takes it to be, for the most part, mathematics and physics, along with the cruder common-sense knowledge on which they are based. He admits, indeed emphasizes, that psychology is in some respects a distinct discipline, which has to be taken into account and has a certain primacy. Granted these limitations, which are certainly convenient for exposition, the book is a masterly and comprehensive piece of work. It contains, in the reviewer's opinion, far the best treatment that has yet appeared of the problems of inductive generalization. This is the central theme of the book and one on which Lord Russell has barely touched in previous books. There is a discussion of language (Part 2) intended to clear up ambiguities and dispose of fallacies, not very different from that in his "Inquiry into Meaning and Truth". There is a valuable section on probability (Part 5) which is intended to specify the useful but subordinate part which the mathematical theory of probability plays; subordinate, because mathematical theory cannot be applied unless the basic problem of induction is taken as solved already, and because another non-mathematical notion of 'credibility' is required.

The central problem may be stated as follows. It must be granted that the sciences exist and form a body of knowledge which, though incomplete and largely tentative, is growing and claims to be valid; not in the sense of being infallible, but immeasurably better than any alternative. The claim to validity cannot be treated solely as a question of formal logic, for it is a claim that *this* body of factual knowledge is valid because of what it is; not any knowledge or even any like knowledge. We must therefore consider in outline what the sciences say about the world, how this alleged information has been acquired, and then evaluate it.

In the course of the first two inquiries we find that the most advanced scientific thought has its roots in what Lord Russell calls animal inference, or habit. If the tendency of animals to form habits had not run parallel with some sort of habit in their environment, they would not have survived. The utility of advanced scientific knowledge is a continuation of the process of adaptation through habit. Hume was content to leave the argument at this stage, because, after the eighteenth-century manner, he drew a sharp distinction between reason and animal habit, which the twentieth-century thinker sees no reason (or is not habituated) to draw. Lord Russell goes on to formulate minimum postulates which will validate existing scientific thought; or, to put the matter differently, what is the least assumption we can make about corresponding cosmic habit and mental habit to justify our continuing our habitual behaviour in future. He rejects phenomenalism because the physical process of radiation implies that between two observed events something can happen, which by hypothesis is not observed; in short, there cannot be continuity in the world if only observed events exist. He rejects pure empiricism because there must be some general principles, not just particular facts. To develop his system of postulates he uses the notion of 'structures'. The concept of structure may be logical in its origin, as he says; but it is certainly put to empirical use. A special but crucial example will illustrate what would justify such use. When we look at the full moon, is there literally, not metaphorically, the same kind of circular structure in the immediate datum of experience, in the astronomical object, in the intervening physical processes of radiation between the moon and our bodies, and in the physiological processes inside our bodies? If we can postulate such isomorphism (as Kohler calls it) it is easy to establish a theory of perceptual and scientific knowledge. But if we do, are not such isomorphic structures of the nature of Platonic forms, archetypes which make things what they are and also make them knowable? In recent writings Lord

Russell has fought shy of a realist view of universals, though never committing himself to nominalism. It looks as though he had returned to earlier views (as in "The Problems of Philosophy") or gone further still in realism.

Lord Russell puts forward his postulates as validating scientific knowledge. To anyone who objects that he has never believed them or even thought of them and does not see why he should, what is Lord Russell to reply ? Within the bounds of Hume's philosophy there is no reply except the kind which Hume himself supplied inadvertently. In the very process of dismissing causality as illusory, Hume used the notion of cause. The other reply would be a 'transcendental deduction of categories': Would Lord Russell desert Hume's camp, where he has dwelt so long, for Kant's ; and after all the hard things he has said about Kant ? Or is there another alternative ?

Some few minor complaints can be made about Lord Russell's discussion. He assumes that experience begins with a private ego-centric space, and he does not explain how, from that starting point, we can ever arrive at the public universal space required by physics. There is a chapter on the principle of individuation ; but the problem is shelved rather than solved.

After all allowances for blemishes have been made, this remains a very fine and characteristic piece of work ; written, too, with all the clarity, wit and gusto we have learned to expect.

A. D. Ritchie

AMERICAN USES OF GROWTH REGULATORS

Growth Regulators for Garden, Field and Orchard

By John W. Mitchell and Paul C. Marth. Pp. vii+129. (Chicago : University of Chicago Press ; London : Cambridge University Press, 1947.) 15*s*. net.

THIS book deals with the practical application of plant growth regulators in agriculture and in horticulture ; it has the initial merit that its authors have richly contributed to the studies of such applied science. In a very short section an introduction is effected to the various groups of available chemicals tabulated according to their chemical affinity ; for readers unfamiliar with recent progress this section could with advantage have been enlarged to include some consideration of the mechanism of the responses involved and some analysis of the reactions induced. But proceeding apace, the authors review the value of '2, 4, D' and 2, 4, 5, trichlorophenoxy acetic acid as herbicides, giving long lists of the resistant and susceptible plants, using only their common American names. But the discussion briefly deals with factors that influence the effectiveness of the chemicals ; temperature and soil conditions are not overlooked, nor are precautionary measures neglected. Reports of the use of other such compounds, at lower concentrations, to facilitate the vegetative propagation of plants, form a large section of the entire work, and the lengthy tables show many responsive plants and details of treatment. Botanical names and common names assist the reader here. Perhaps a critical discussion of the after-effects of certain substances, effective in root formation, but tending to delay bud development when used at rather too high concentrations, would have increased the value of this section. The use of esters of naphthalene acetic acid—intentionally—to inhibit the development of buds and 'sprouts' is well described, and here British readers will see that roses are so treated under American conditions of marketing the plants. The storage of potatoes may be prolonged without sprouting ; as there is always a chance that tubers meant for planting may be cooked, it is reassuring to read that no 'off' flavour nor any ill-effects were observed when such were used boiled or as chips ! Although young fruit trees have been retarded to some extent, without injury, it has not yet proved practical to delay the opening of fruit buds to avoid possible damage by frosts.

Paul C. Marth has been a pioneer in the use of growth substances to control the pre-harvest fall of fruit from the trees, and the review of the use of water sprays, of dust carriers, and of other methods of application, including the use of aeroplanes, is a valuable feature of this book, as are also the remarks concerning the importance of correct timing of the treatments. Naturally, the discussion of varietal responses centres around well-known American kinds and does not include much concerning British varieties.

A short chapter is included on the use of ethylene and other substances for accelerating the ripening process of bananas and citrus fruits. Similarly there is mention of the use of di-nitro-*ortho*-cresol and di-nitro-*o*-*cyclo*hexyl-phenol to thin out fruit blossoms, although these chemicals do not fall within the category of active growth substances as generally understood by British workers. The use of β-naphthoxy acetic acid and other compounds to produce seedless fruits is discussed.

The illustrations are good and helpful. There are lists of available American proprietary preparations given at the end of the chapters.

We have for long appreciated the work of the university presses concerned, and another example upholds the standard they set. M. A. H. Tincker

COLOUR

The Color of Life

By Arthur G. Abbott. Pp. xxi + 294 + 7 plates. (New York and London : McGraw-Hill Book Co., Inc., 1947.) 6 dollars.

COLOUR in life is inescapable, though some, being more observant, see more of it, especially the colour of natural things and natural phenomena, than others. Colour always has been and always will be associated with various arts and crafts in which the colouring agency such as dyestuff, as in the colouring of textiles, or the pigment, as in painting, is often man-made as well as man-assembled. Many of the great men of science since the time of Newton and his contemplation of the rainbow have been concerned with colour and have sought to explain just what colour is. Many are the known facts and theories about colour, for indeed the subject can be approached from many aspects. Thus the characterization of colour by mathematical symbols gives satisfaction to some, whereas others believe that the psychological effects of colour are the more worthy of study. Altogether there is to-day a greater and more widespread colour-consciousness, more appreciation of colour in Nature and in the broad activities of everyday life than ever before. It finds practical expression, for example, in the painting of factory walls and machines, in which colour now contributes to safety and eye comfort as well as to cleanliness and decoration in the ordinary sense.

The author, recognizing these things and clearly being fascinated by the subject, has sought to present its enormous sweep in a series of cameos in twenty chapters arranged in six groups under the following headings: 1, foundations of colour—light, matter and sight; 2, colours by Nature and how produced; 3, colours by man and how produced; 4, guides to use of colour—colour terms and names, harmony and discord in colour combinations; 5, colour for everyone—apparel and building; and 6, relation of colour to man's progress—special uses of colour.

In the result the substance of each chapter is a précis, or in some cases a partial abstract, of the reference books listed at the end of each chapter. At this point it is only fair to repeat some of the author's introductory words, namely: "This book is not intended to be a guide for any science, trade or profession, but a source of pleasure and profit for the average man, woman and child ... . to present a variety of facts, theories, experiences and observations about colour that will be interesting and useful. . . ."

There remains the question of accuracy. Are the factual statements which the author has made correct? On this I have to record that the chapter entitled "Paints" shows some confusion of thought, though comparatively little editing would have removed any cause for complaint. After all, it is not reasonable to be able to describe all the pigments, white and coloured, and the principles of paint manufacture, in nine not very closely printed pages. On the other hand, I was intrigued to read among a multitude of 'titbits' about a great variety of subjects that turkey flesh should have no purple tinge, as this marks an old bird—I shall examine my next turkey with added interest.

L. A. Jordan

TREATISE ON ZOOLOGY

Traité de zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 11: Échinodermes, stomocordés, procordés. Par P. Brien, M. Caullery, L. Cuénot, A. Dalcq, C. Dawydoff, P. Drach, H. Harant, G. Waterlot. Pp. viii+1,078. (Paris: Masson et Cie., 1948.) 3,800 francs.

To older zoologists the title "Traité de zoologie" will recall the extensive work published by Prof. Edmond Perrier, the first volume of which appeared in 1893. It held its place on the bookshelf for many years, and even now some parts bear reference; but obviously in fifty years a vast amount of water has flowed under the bridge. The present work has a similar format and 'get up', but has a striking difference in that it has ninety-three collaborators from France, Belgium, Switzerland, Algiers, Egypt and Morocco, united under the direction of Pierre-P. Grassé, professor at the Sorbonne. This new treatise is planned to extend to seventeen volumes, each of which will consist of about 1,000–1,200 pages and will be fully illustrated.

The publication of such a large work has dangers not encountered in issuing a single large volume, or a small number of volumes. It may spread over such a long period that the first volumes are quite out of date before the last ones appear, so that it does not form a usable whole; or it may suffer the fate of Lankester's "Treatise", Délage et Hérouard, or Kükenthal und Krumbach, which were never completed. It is to be hoped that the present commendable work will avoid these dangers, and the fact that a large number of authors are collaborating may help. Four more volumes are scheduled to appear in 1949, and at least three in 1950; and if this rate is maintained the work should be completed in little more than four years, a not unreasonable time. The large number of contributors should also make it possible for each section to be up to date and authoritative, for it is obviously impossible for one or even a small group of authors to cover adequately the vast field of modern zoology.

The volume at present under review, while it is number 11 in the series, is actually the first to appear, and so may be taken as a sample of those to follow. It contains 1,078 pages with 993 figures, 11 of which are in half-tone, 11 reinforced by colour, and the remainder in line block; they are deserving of high praise. The volume deals with the systematics, anatomy and biology of the Echinodermata, Stomochorda (Hemichordata) and Prochorda (Tunicata and Cephalochordata). Each section is provided with its own bibliography, which varies in extent according to the availability of recent bibliographies. The principal contributors are Profs. L. Cuénot (Nancy), C. Dawydoff (Paris), P. Brien (Brussels) and P. Drach (Sorbonne). The group Stomochorda is set up because the pharyngeal diverticulum lies near the mouth, and it is held that this is a structure *sui generis* and is not strictly homologous with the notochord of the true chordate. The structure itself is referred to as a stomochord (stomocord) to emphasize this distinction. The recent researches of O. M. B. Bulman and Kozlowski, taken fully into account, show that the Graptolites are more closely allied to the Pterobranchia than they are to the groups with which they have been associated previously, the Sertularian Hydrozoa or the Bryozoa, and consequently they have been included as a class of the Stomochorda. Cuénot has a discussion (pp. 359–361) of the relationship of the dipleurula of the Echinoderms to the tornaria of the Enteropneusts, and of the basic trimerism of the former phylum as indicated by the development of the cœlom. This, read in conjunction with the fuller discussion by Dawydoff of the Stomochorda and their affinities (pp. 511–532), shows clearly that both authors recognize an ancestral relationship between the Echinodermata and the Stomochorda, and, of course, the latter are clearly related to the Prochordata. Thus the three groups are logically included in the same volume.

On the whole the book is excellently printed and illustrated, and the paper is very good. A detailed index is furnished and a very full table of contents which is placed right at the end of the volume. It is a pity that a number of slips have been allowed to pass uncorrected, for example: p. 297, deutoplosme for deutoplasme; p. 362, Mac Millan for Macmillan; p. 488, McIntosch for McIntosh; p. 452, Bulloc for Bullock; p. 947, fig. 407, *e* in the diagram is *Fe* in the legend; and p. 494, fig. 408, *v s* in the diagram is *vis* in the legend, etc. Apart from these, the authors, editor and publishers are to be congratulated on initiating a series of volumes that should prove most useful to all zoologists, and we wish their venture every success.

C. H. O'Donoghue

Medicine and Science in Postage Stamps

By W. J. Bishop and N. M. Matheson. Pp. 82 (33 plates). (London: Harvey and Blythe, Ltd.; H. K. Lewis and Co., Ltd., 1948.) 7*s*. 6*d*. net.

WHILE the emphasis in this little book is on medical interest, the authors also refer briefly to scientific workers in the widest sense who have been commemorated by special stamps; among whom are Tycho Brahe, Ampère, Descartes, Linnæus, Mendel, Berthelot, Edison, Marconi and the Curies. The book contains a 16-page account of the reasons for the issue of such stamps; there are short sections on portrait stamps, Red Cross stamps, various tuberculosis stamps, illustrations of hospitals and other medical institutions, the use of medical symbols and apparatus, and other stamps of medical interest. There follow thirty-three plates giving black-and-white reproductions of 148 such stamps from the authors' collections. The book ends with 23 pages of biographical notes, arranged alphabetically, relating to the portrait stamps mentioned. There is also a bibliography.

In addition to stamp collectors among the medical and related professions to whom the book is specifically addressed, it may well arouse interest in this instructive hobby among others interested in scientific developments.

Meson Theory of Nuclear Forces

By Wolfgang Pauli. Second edition. Pp. vii+69. (New York and London: Interscience Publishers, Inc., 1948.) 12*s*.

THIS second edition differs from the first (reviewed in *Nature*, **160**, 418; 1947) only in a few short sections, where instead of older experiments some more recent ones are discussed (concerning the angular distribution of proton-neutron scattering, p. 56, and the consequences of strong coupling theory, p. 64). The most interesting feature of the new edition of the little book is its preface, where the author refers to new discoveries incompatible with the present theory, such as the existence of different kinds of mesons and the absence of negative meson capture by the lighter nuclei. He hopes that artificial production of mesons recently achieved in the United States will bring forth a great change of the whole situation in the near future.

Isomerism and Isomerization of Organic Compounds

By Ernst David Bergmann. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. xi+138. (New York and London: Interscience Publishers, Inc., 1948.) 21*s*.

THIS little book presents the material of six lectures delivered by the author during 1945–46, and deals only with those aspects of its subject which have most interested him. This limitation is made clear in the preface, and the would-be reader should not be misled by the wide title of the book into expecting even an outline of the whole field. The book is a very personal approach to the subject, and presents an individual outlook which will probably not commend itself to the majority of qualified readers; thus, it will surprise many to find, in a chapter entitled "Mechanism of Substitution Reactions; Racemization and Walden Inversion", only one reference, and that purely experimental, to the work of Ingold and his school. Some of the theoretical interpretations are also highly individual and will be regarded by many as very questionable; for example, the surprising statement (p. 119) that, in the rearrangement of phenyl allyl ether, "a van der Waals' link is established between the unsaturated γ-carbon atom and the ortho position". Although, as the author hopes in his preface, the book may provide "food for thought" for the critical reader, it is certainly not suitable for students, and from this point of view its high price is to be welcomed.

H. N. RYDON

The Faith of Reason

The Idea of Progress in the French Enlightenment. By Charles Frankel. Pp. x+165. (New York: King's Crown Press; London: Oxford University Press, 1948.) 16*s*. net.

FOR the philosophers of the French *Enlightenment* theirs were grand days. They were grand because the errors of history and of circumstance were at long last understood; reason would put everything right. Thus the enthronement of scientific method; the fields were white to harvest with the fruits of Cartesianism, all ready for the garnering; and this not necessarily against the winter, for such seasons would be mild in future, their edges rounded off by a generous humanity, which quality, by the way, was thought to be identical with reason itself.

The brilliance of these savants is beyond question; what seems odd to us now is their limited imagination, due in the main to a system of metaphysics telling them exactly what they were about to find, and keeping them in fetters while looking for it. Nevertheless, we are assuredly their debtors in the sphere of moral progress.

Much of the temper of the *philosophes* is of concern to society to-day, especially when the uses of science are subject to attack, and there is much talk of 'irresponsibility'. Dr. Charles Frankel, aided by the King's Crown Press, has performed a valuable service in producing this monograph. Between its covers can be found a critical, but not pedantic, account of an age at the moment somewhat neglected in the history of thought.

F. IAN G. RAWLINS

Shetland Sanctuary

Birds on the Isle of Noss. By Richard Perry. Pp. 300+32 plates. (London: Faber and Faber, Ltd., 1948.) 25*s*. net.

THE island of Noss on the eastern side of the Shetland group is a well-known resort of seabirds, the great cliff known as the Noup of Noss that faces the North Sea being a breeding place of countless kittiwakes, guillemots and razorbills, plus many gannets. In addition, great skuas and Arctic skuas nest on the grassy expanse of the island. These are but some of the bird attractions of Noss. The island well deserves the title of "Shetland Sanctuary" under which Mr. Perry describes it in his latest book.

In this book the author tells us of his five months work on Noss, during which he made his headquarters in the old farm-house, now, alas, falling into disrepair, while his wife and child found a less arduous habitation on the nearby island of Bressay. To appreciate the author's results one must read his careful studies of the great skua, the Arctic skua and the gannet, with sidelights on many other birds. In the space of a brief review it is difficult to give much idea of them, and we must refer the reader to the book itself, which in our opinion is the best Mr. Perry has written.

F. P.

COCOA DISEASE IN THE GOLD COAST

FOR some years past, increasing uneasiness has been felt about the future of cocoa in West Africa and particularly in the Gold Coast. Trees began to die in ever-increasing numbers, and at first the trouble was attributed to 'die back' and physiological troubles, due to the excessive removal of high forest which occurred during the rapid opening up of the country for new plantations. This it was believed let in the dry 'harmattan' winds from the Sahara, causing a less favourable environment for the cacao tree. As a remedial measure the establishment of shelter belts of high forest was recommended, and in due course they came into being; but the trouble still continued to spread and remained an unsolved puzzle until one of the scientific officers, stationed on the newly opened Cacao Research Station, established that the cause is a virus disease. The research station is situated at Tafo in the middle of one of the badly infected areas of the Eastern Province, and was opened about ten years ago. It has done valuable work in establishing that several types of virus are responsible, that infection is conveyed by particular species of mealy bugs, and that certain species of indigenous forest trees can serve as alternative hosts.

The Station has also devoted much attention to methods of control and has come to the conclusion that the basic method for dealing with a disease of this type is the removal of sources of infection. This means cutting out not only trees that are obviously beyond hope of recovery, but also trees that show symptoms of the disease but are still bearing some fruit. Most of the cocoa farmers are poorly educated men, with only two or three acres apiece, and it naturally went against the grain to ask them to destroy trees that were apparently still capable of producing a few pods, especially at the present time when prices are exceptionally high. Attempts to apply this 'cutting out' cure have been unpopular and have been strongly resisted by the growers. Unfortunately also, local politics were dragged in, so that serious disturbances took place in March 1948, with the result that the legal powers to compel cutting out, which already exist, have not been enforced. For nine months or more the disease has to all intents and purposes been allowed to spread unchecked, for the cutting out campaign has been suspended.

As a consequence of these events, a special commission was sent out by the Colonial Office in May 1948 to report on the disturbances, and acting on one of its recommendations, a panel of three plant pathologists of international repute, drawn from countries not commercially interested in cocoa growing, was selected to study the disease and report on its control or eradication. These men were appointed to the commission after consulting the United Nations Food and Agriculture Organisation, and their report has now been issued*, giving an entirely independent and up-to-date account of the cocoa position in the Gold Coast. In the first place, they entirely endorse the conclusion reached some years ago by the West African Cacao Research Station at Tafo, that cutting out is, at present, the only practical control measure. They point out the magnitude of the problem involved, as this means cutting out at least fifty million diseased cacao trees and several million wild host trees. Nobody knows how many cacao trees there are in the Gold Coast, but the figure may be of the order of 400 million; under these proposals, therefore, it seems probable that one-eighth of the existing cacao trees would have to go. So far, under the existing voluntary cutting-out scheme, not more than three million trees have been removed.

The urgency of the problem is emphasized since the disease is spreading at the rate of fifteen million trees a year, and has recently made great headway, because control measures have practically ceased since the March riots. The Eastern Province was the first area affected, and large blocks of cacao have been killed in what was formerly the most productive cocoa belt. The disease has spread to Ashanti, where former isolated outbreaks have extended to an alarming degree. The Western Province is still more or less in the period of sporadic outbreaks, but there is every prospect of its following the other two provinces unless adequate measures are taken. The Commission points out that far more vigorous action will have to be taken if there is to be any hope of saving the industry. Not only will the staff of the Agricultural Department need to be greatly strengthened, but means will have to be taken to bring home to all sections of the public the urgency of the matter and the definite threat to the whole industry, on which depends ultimately the prosperity of the entire country; for the Gold Coast relies to a frightening extent on the revenue obtained from its cocoa crop.

The Commission recommends, therefore, that the first and most important task is to educate all classes of the population to the seriousness of the position, and to secure their support for the 'cutting out' campaign. Until public opinion has been educated up to this point, it will not be easy to carry out the drastic campaign envisaged. It must be remembered that cocoa in the Gold Coast is produced by many thousands of peasants farming two or three acres each, or working land belonging to absentee landlords. The majority of these men are illiterate, and the difficulty will be to bring home to them the facts of the case. Something can be done by an extension of the radio system to the villages and markets; but the best way is probably personal conversation with a representative of the Government. Even a greatly enlarged staff in the Agricultural Department could only contact a small proportion, and it will be necessary for the campaign of enlightenment to be carried on by members of all Government departments, native authorities and chiefs' councils, and the Press.

It is obvious that, for the cutting-out programme to be effective, it must not only be vigorous but also thorough. It will be useless to treat most of the fields in an area and leave two or three untreated plots because the owners refuse to co-operate. These plots will be the cause of rapid re-infection of the neighbouring fields. Eventually it is hoped that public opinion will insist that all must play their part for the general good. It is obvious, however, that time will be needed to reach such a desirable state of affairs, and the need for a publicity campaign emphasizing the vital stakes at issue is all the more urgent.

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* Colonial Office: Report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast. (Colonial No. 236.) Pp. 10. (London: H.M. Stationery Office, 1948.) 3*d.* net.

While endorsing the control methods of the Cacao Research Station, the Commission is inclined to think that the method of cutting out may need to be even more stringent if the disease is to be eradicated permanently from a particular area. It is pointed out that it is not sufficient merely to cut out trees showing signs of the disease; neighbouring trees that are in contact are also probably diseased, although they may not show symptoms until a later stage. The contact trees, therefore, will also have to go. It will be difficult to persuade the peasant farmer to cut out an apparently healthy tree by assuring him that it is the only way that his crop can be saved in the future. Since only a vigorous and thorough removal of infection sources can be expected to achieve a reasonable degree of success, the Commission thinks it advisable that the limited staff at present available should concentrate its efforts in areas of lesser infection, particularly Ashanti and the Western Province.

It may be that eventually the so-called 'raging belt' area of the Eastern Province, where the cacao fields have been practically wiped out, may prove to be the best place to resuscitate the industry, and at the same time replace the old methods by something more in keeping with the present time. In this area large areas of cacao have ceased to exist—only here or there a few trees struggle on. With the co-operation of the chiefs and their peoples, it might be possible to start new plantations on modern lines. This would entail the planting of cacao in large compact units instead of thousands of small scattered plots as at present. The area selected would have all existing cacao and wild host trees completely removed, and be left fallow for two or three years before replanting. The new area would be planted in rows at the most desirable distance apart, and this would enable spraying machinery to be worked if at any time action was needed in the future. At present, Gold Coast cacao is planted in a most haphazard way, and it is impossible to get into the crop to spray or prune.

A plantation of the type envisaged would have a relatively small periphery for its acreage, and border control of invasion from outside should be comparatively easy. There would be difficulties over land tenure and other customs, and these would have to be the subject of careful consideration and of goodwill on the part of the village authorities.

The fact remains, however, that one cannot envisage the Gold Coast succeeding in reviving its cocoa industry by relying on the old happy-go-lucky methods. There would be no guarantee that a crisis similar to the present one might not again arise. It is unimaginable that a disease of this nature could have got out of hand in this way if the crop had been properly cultivated and organised on a more rational basis. The present calamity that has befallen the Gold Coast cocoa crop may in the end, therefore, prove a blessing in disguise. If the growers are wise, they will take the opportunity of putting their industry on a sound basis. They will learn to treat their cacao as an orchard crop and not as a bit of jungle.

The establishment of plantations on the lines mentioned will enable modern up-to-date methods to be employed and better material planted. The research workers must have time to make their investigations; but already there are signs that higher-yielding, disease-resistant varieties may be forthcoming, and better methods of cultivation, fertilizing and disease control become available.

The Commission points out with reason that inadequate attention to the situation up to the present has allowed the disease to gain such headway that effective and immediate action is needed. One of the problems that as yet remains unsolved is the extent to which wild trees and plants are alternative hosts. It is known that the silk cotton tree, the cola and three or four species of Sterculiaceæ are carriers of the virus; but there may be others, and the search is still being continued. The destruction of some of these trees will present a big problem, for many of them are giants of 200 ft., with buttressed roots rising to 30 ft. in height. The possibility of destroying them by chemical means is being considered, but even so the task of killing several millions of such trees will be a stupendous one. The replanting of lightly affected areas will also prove difficult. It seems that more preliminary work is needed to ascertain the margin of time when it can be deemed safe to replant in lightly affected areas, from which a few diseased trees have been removed. Young cacao trees apparently show few signs of disease for the first three or four years, but after that, when their canopies become contiguous, they may become re-infected unless a complete sweep has been made of all possible sources of mealy bug infection.

The best hope for the future lies in continued research on the lines indicated in the report, coupled with a determination to re-establish the industry on rational lines; and for the present to attempt to alleviate the existing crisis by intensifying the 'cutting-out' campaign. GEOFFREY EVANS

RECENT ADVANCES IN THE CHEMISTRY OF HYDROCARBONS*

By Dr. S. F. BIRCH
Research Station, Anglo-Iranian Oil Co., Ltd.

THE demand for highly branched *iso*paraffins for use in higher-performance aviation fuels has stimulated research during the last ten to fifteen years into methods for producing such hydrocarbons in large quantities from available raw materials. Of the processes resulting from this work those based on isomerization and on alkylation are of outstanding importance.

In the isomerization process the molecular structures of the paraffins, particularly of the normal members which occur naturally in petroleum, are re-arranged to the required branched structures. Such re-arrangement is a reversible first-order reaction in which at low to moderate temperatures the equilibrium favours branched structures, but with increasing temperature the equilibrium shifts towards straight-chain structures. In the absence of catalysts the attainment of equilibrium is extremely slow even up to temperatures at which the hydrocarbons are thermally unstable, while in the presence of catalysts side-reactions become more marked as the temperature increases.

The most satisfactory catalysts for paraffin isomerization are the aluminium halides promoted by certain compounds such as hydrogen halides, alkyl halides, oxygen, water and olefins. These combinations are extremely active under relatively low-temperature conditions, apparently acting heterogeneously at liquid – liquid or liquid – solid interfaces. Since a promoter is necessary, the aluminium halide itself does not appear to be the catalyst. It has been suggested that acids of the structure $HAlX_4$ are the true catalysts, but this takes no account of the findings of Wackher and Pines that, in the isomerization of butane, traces of olefins, water or oxygen are necessary in addition to the hydrogen halide. Also, a recent study by Fontana and Herold[1] has shown that the vapour pressure of hydrogen bromide in contact with aluminium bromide is not abnormal, as it might be expected to be if such a complex were formed. The most plausible mechanism is that put forward by Wackher and Pines[2] on the basis of their work with partially hydrolysed aluminium halides. These workers found that the most effective catalyst was obtained by adding one molecule of water for each molecule of halide present, and, by using deuterium oxide in place of water, they were able to compare the rate of deuterium – hydrogen exchange between $DOAlBr_2$ and butane while the hydrocarbon was isomerized. The results of this investigation indicated that it is the bromine of the partially hydrolysed halide that takes part in the reaction, and accordingly the following mechanism has been put forward :

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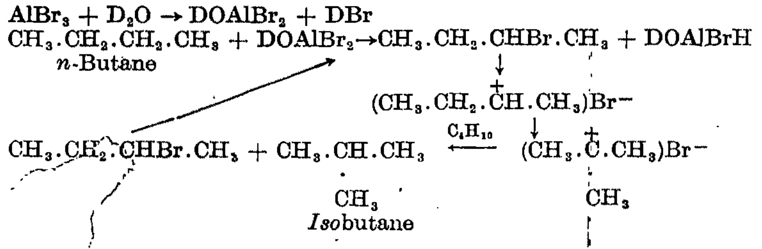
* Substance of a series of lectures delivered at the Royal Institution, beginning November 16.



$$\mathrm{AlBr_3 + D_2O \rightarrow DOAlBr_2 + DBr}$$
$$\underset{n\text{-Butane}}{\mathrm{CH_3.CH_2.CH_2.CH_3}} + \mathrm{DOAlBr_2 \rightarrow CH_3.CH_2.CHBr.CH_3 + DOAlBrH}$$
$$\downarrow$$
$$\mathrm{(CH_3.CH_2.\overset{+}{C}H.CH_3)Br^-}$$
$$\downarrow$$
$$\mathrm{CH_3.CH_2.CHBr.CH_3} + \underset{Isobutane}{\mathrm{CH_3.\underset{CH_3}{CH}.CH_3}} \xleftarrow{\mathrm{C_4H_{10}}} \mathrm{(CH_3.\underset{CH_3}{\overset{+}{C}}.CH_3)Br^-}$$

In alkylation, highly branched *iso*paraffin molecules are built up by the combination of low molecular weight olefins and paraffins such as are normally available from refinery operations. Using a complex catalyst consisting of boron trifluoride activated by nickel powder and hydrogen fluoride or water, Ipatieff and Grosse[3] were the first to show that such a reaction is possible, although Parks and Huff[4] seem to have concluded some time previously from thermodynamical considerations that this type of reaction is feasible. It was next reported by Frey and Hepp[5] that such alkylation could also be effected non-catalytically under rather drastic conditions of temperature and pressure, 500° C. and 300 atmospheres ; thermal alkylation was, however, possible only with lower olefins and paraffins, except for methane and ethane, which have so far resisted all attempts, catalysed or uncatalysed, to react in this way.

Thermal alkylation has been employed technically to produce 2.2-dimethylbutane (*neo*hexane) from *iso*butane and ethylene on a comparatively large scale, but the greatest developments in alkylation processes have followed the use of the practical catalysts, aluminium chloride (activated with hydrogen chloride), sulphuric acid and hydrogen fluoride. Aluminium chloride possesses the advantage over sulphuric acid and hydrogen fluoride that it enables normal- as well as *iso*paraffins to be alkylated ; normal paraffins are presumably first isomerized to the *iso* form. Technically, aluminium chloride has been employed to produce 2.3-dimethylbutane ('di*iso*propyl') from *iso*butane and ethylene, a reaction that could not be brought about by the other two catalysts. This formation of di*iso*propyl rather than *neo*hexane as in thermal alkylation has been explained by Schmerling[6] on the basis of a chain mechanism involving the preliminary formation of an alkyl halide from the olefin and hydrogen chloride, leading to a *neo*hexyl structure which then isomerizes to the di*iso*propyl structure in the presence of aluminium chloride.

The most generally employed alkylation catalyst is sulphuric acid, hydrogen fluoride being used to a less extent. Both compounds are completely ineffective for the alkylation of normal paraffins, and their use is restricted to *iso*paraffins. The alkylation of *iso*butane with butenes has been the most important technical alkylation, although propene and pentenes have also been used. Schmerling has suggested a mechanism for sulphuric acid alkylation similar to that for reactions catalysed by aluminium chloride ; but this seems less likely, and the mechanism must still be regarded as obscure. The products from sulphuric acid alkylations consist of a complex mixture of *iso*paraffins boiling over a wide range of temperature, and under favourable reaction conditions the major part is of the desired molecular weight. By the end of the War, some 5½ million tons a year of *iso*paraffins were being produced by alkylation, and the process is still being operated on a considerable scale.

While isomerization and alkylation processes enabled most of the high-performance aviation fuels to be produced in vast quantities, one material, 2.2.3-trimethylbutane (triptane), could not be made in the required amounts by these methods, and it was necessary to devise alternative processes. Two solutions to this problem were eventually forthcoming. Thus Lovell and Miller[7], on the basis of an observation in 1882 by Eltekoff[8] that 2.3.3-trimethylbutene-1 was a by-product from the treatment of trimethylethylene with methyl iodide and litharge, investigated the interaction of trimethylethylene with methyl chloride in the presence of lime, and obtained a product containing appreciable quantities of 2.3-dimethylbutene and 2.2.3-trimethylbutene (triptene). By recycling the dimethyl compound, further methylation took place, and an enhanced yield of triptene was available. Hydrogenation of the triptene gave the desired triptane. A second route to the same hydrocarbon was discovered by Ipatieff and Haensel[9], who found that, in the presence of metals such as cobalt and nickel and under hydrogen pressure, demethylation of higher *iso*paraffins occurs to yield the next lower homologue and methane. By applying this reaction to 2.2.3-trimethylpentane, one of the *iso*octanes formed by the hydrogenation of butene–*iso*butene codimer, triptane was obtained. Owing to difficulties encountered in separation of the triptane from the original *iso*octane and accompanying *iso*heptanes, the method of Ipatieff and Haensel was less successful than that of Lovell and Miller.

Contemporaneously with the need for *iso*paraffins for aviation fuel, the War also intensified the demand for large quantities of butadiene and styrene for synthetic rubber production. These two compounds were obtained similarly by the catalytic dehydrogenation of butane and ethylbenzene respectively. Considerable difficulties had to be surmounted to obtain the desired products, for paraffin dehydrogenation is a strongly endothermic, reversible reaction in which comparatively high temperatures (400–700° C.) are necessary to favour dehydrogenation. At these temperatures cracking and, when the paraffins contain more than five carbon atoms in the chain, cyclization, may be marked.

The dehydrogenation of butane on a technical scale[10] was carried out as a two-stage process, the butane being first converted to butenes over a chromium oxide–alumina catalyst at 450 – 490° C., the light gases and butane being separated, and the purified butenes then being further dehydrogenated to butadiene at a somewhat higher temperature in the presence of ten to twenty volumes of high-temperature steam. The addition of steam had the triple advantages of reducing cracking, providing heat for the reaction and removing carbonaceous deposits from the catalyst. Butadiene was separated from butenes and butanes by azeotropic distillation.

Ethylbenzene has been dehydrogenated to styrene under somewhat similar conditions[11] using a chromium oxide – alumina catalyst. The separation of styrene (b.p. 145° C.) from unchanged ethylbenzene (b.p. 136° C.) presented a problem which was complicated by the fact that styrene polymerizes readily at its boiling point under atmospheric pressure. The difficulty was eventually overcome by adding a small quantity of sulphur as a polymerization inhibitor to the feed to the still, working at reduced pressure and dividing the necessary 70-plate fractionating column into two sections.

As already mentioned, under dehydrogenation conditions, hexane and the higher paraffins tend to undergo cyclization to aromatic hydrocarbons. This appears first to have been observed by Moldavski[12], but has also been extensively studied by a number of workers in Great Britain[13] and in the United States. A molybdenum oxide – alumina catalyst is better for cyclizations than a chromium oxide – alumina one.

An interesting offshoot of the work on the production of butadiene by dehydrogenation of butane was the preparation of thiophenes from sulphur and lower paraffins containing four or more carbon atoms in a chain. Thiophenes are now being produced by this means on a considerable scale in the United States[14], and a new field of chemistry is opening up.

It is not possible to deal adequately here with all the new advances in hydrocarbon chemistry, but, in addition to those indicated above, there may be mentioned sulphochlorination and sulphoxidation, telomerization, the 'Oxo' synthesis (see below) and the new acetylene chemistry developed in Germany.

The introduction of a sulphonyl chloride group into paraffins by treatment with chlorine and sulphur dioxide in presence of actinic light was discovered by Reed[15] in the United States. However, the greatest development of the process has probably been in Germany during the War when, on a considerable scale, C_{14}—C_{16} normal paraffins from the Fischer–Tropsch reaction were used to produce alkanesulphonate-type detergents[16]. In a modification of this reaction a paraffin was treated with oxygen and sulphur dioxide in the presence of acetic anhydride during irradiation with ultra-violet light; a peranhydride of acetic and alkanesulphonic acid resulted, and this decomposed in the presence of more paraffin, sulphur dioxide, oxygen and water to yield the sulphonic acid in the ratio of 7–9 molecules for each molecule of peranhydride decomposed[17].

'Telomerization' is the term employed to denote an olefin reaction that has been investigated extensively in the du Pont Laboratories and elsewhere in recent years. Kharasch had shown that, in the presence of peroxides or when irradiated by ultra-violet light, olefins would add on a molecule of a halogenated methane, a halogen going to one end of the double bond, the rest of the methane molecule to the other[17]. When this is carried out under polymerization conditions, the product contains more than one olefin molecule per molecule of non-olefin[18]; the reaction is then a 'telomerization', the non-olefinic adduct a 'telogen' and the reaction product a 'telomer'. Other types of compound such as chloralkane carboxylic acids and their esters, aldehydes, hydrogen halides, etc., also function as telogens. The reaction is of considerable interest in providing a means for building up long-chain compounds with reactive terminal groups.

From a technical aspect one of the most important reactions discovered in recent years is the Roelen reaction or 'Oxo' synthesis, which involves the simultaneous addition of hydrogen and carbon monoxide to an ethylenic bond under certain conditions of temperature and pressure in the presence of cobalt catalysts[19]. Simple olefins yield a mixture of the two isomeric aldehydes to be expected from the addition of the formyl group to either end of the double bond; but structural variations in the olefin influence the proportions of the aldehydes formed, and, in the extreme case when a tertiary carbon atom is at one end of the double bond, the formyl group is added only to the other end. If tertiary carbon atoms occupy both ends of an ethylenic linkage, reaction may still occur if, under the experimental conditions, isomerization to a suitable configuration can take place first[20].

Of outstanding interest theoretically as well as technically is the new field of chemistry that has been opened up by Reppe's work on acetylene reactions[21]. From the many reactions examined, two are of particular interest, namely, the production of acrylic acid from acetylene, carbon monoxide and water in the presence of nickel carbonyl, and of butine-1.4-diol from acetylene and formaldehyde in the presence of copper acetylide. The former reaction opens a new route to polymer-forming materials, the latter to a wide range of organic intermediates including butadiene and tetrahydrofurane.

The polymerization of acetylene to *cyclo*octatetraene in the presence of certain nickel catalysts[22] opens up a new field for investigation by providing a convenient source of this extremely interesting hydrocarbon.

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[16] B.I.O.S. Final Report No. 478.

[17] *J. Amer. Chem. Soc.*, **69**, 1100 (1947).

[18] British Patent 581,899.

[19] F.I.A.T. Final Report 1000.

[20] Cf. Kaulemanns, Kevante and von Bavel, *Rec. trav. chim.*, **67**, 298 (1948).

[21] B.I.O.S. Final Report No. 266.

[22] B.I.O.S. Final Report No. 137.

OBITUARIES

Prof. John Percival

JOHN PERCIVAL was born at Carperby in Wensleydale on April 3, 1863, and died on January 26, 1949, being survived by his widow and son.

He was educated locally, but later proceeded to Cambridge and graduated from St. John's College in 1888 with honours in Parts I and II of the Natural Science Tripos. Even during his boyhood he was an ardent field naturalist and, while still a student, published a "Flora of Wensleydale" which listed 653 species and varieties, of which all but ten had been seen by himself.

In 1891 he was appointed junior demonstrator in the Chemical Laboratories of the University of Cambridge, and joined that small band of educational pioneers, led by A. D. Hall, who carried agricultural science into the rural areas. During three years he gave numerous courses of "Cambridge University Local Lectures" on botany and chemistry in relation to agriculture, and it was this intimate contact with Surrey and Suffolk farmers and experience in wedding science to agricultural practice that laid the pattern of his life-work.

When the Wye Agricultural College was founded in 1894, Percival was appointed professor of botany and concentrated his attention mainly on hops and cereals. He published several papers on the history, varietal development and diseases of the hop plant which laid the foundations on which E. S. Salmon was to build so brilliantly later. He assembled a living museum of cereals, described in his pamphlet "The Chief Species, Races, and Varieties of European Cereals", this being his first essay in a field which was to become the dominant passion of his life. In 1902 he published a short paper in which the causal relation of *Stereum purpureum* to silver leaf disease was first demonstrated, a problem later developed by F. T. Brooks. In his teaching at Wye, Percival felt acutely the lack of any text-book of his subject, and met this need by his "Agricultural Botany"; in the course of thirty-eight years this ran into eight editions and was translated into many languages. It is easy nowadays to criticize this volume; but, in its day, it was a pioneering effort in a new field, a field itself almost created by Percival, and the several editions have largely shaped the development of the subject in university and college teaching.

In 1902, Percival was appointed director of the Agricultural Department in what was then the University College, Reading, and in 1907 became professor of agriculture. For ten years he had to cover the whole field of agriculture, and his publications ranged over such diverse topics as weeds, mountain pines, manures and manuring, and the "Soils of Dorset"; in 1907 he was one of the presidents of the Second National Conference of the Poultry Industry. In 1910 he published his researches on "Potato 'Wart' Disease", which gave the disease and the pathogen their modern names and laid the foundations of our knowledge of this problem. During this period he was also assembling and making an intensive study of the world's wheats, and building up in Reading a centre of agricultural education and research. In 1910 he published his "Agricultural Bacteriology", again a pioneering effort in a new and rapidly developing field which the book largely patterned.

In 1912 a chair of agricultural botany was established in the College and Percival became the first professor, holding this appointment until his retirement in 1932: in 1926 the College had become the University of Reading. Percival was at last able to devote all his energies to his wheats. Earlier he had founded an Agricultural Botanic Garden containing a living museum of wheats, and he developed this until it comprised many thousands of named species, varieties and races of *Aegilops* and *Triticum* collected from all over the world. In 1921 this work came to splendid fruition in his monumental treatise, "The Wheat Plant", which at once gave him recognition as the foremost world authority: among his correspondence are letters from Vavilov and other specialists containing glowing tributes to "this classic work".

During the next ten years Percival devoted his attention to the cytological analysis of *Aegilops* × *Triticum* hybrids, on which he published several papers, and began the preparation of his book on "Wheat in Great Britain" which was published in 1934, and appeared in a second edition a few months before his death. During his last years he was actively engaged in research on seed germination and seedling growth. In his old Department at Reading there remain his fine herbarium of British plants, his remarkable collection of seeds, a complete set of dried specimens of his wheats with his annotations, and the living museum of wheats and the Agricultural Botanic Garden which he founded.

John Percival was no ordinary man. His force of character, tireless enthusiasm and immense physical and mental energies enabled him to achieve a vast amount of enduring work. He was an accomplished linguist, a musician and artist of merit, an expert photographer, a scholar, and a lover of books, of which he possessed an astonishingly wide and intimate knowledge. He was an inspired teacher with an encyclopædic knowledge of agriculture and botany on which he could draw at will. He was equally at home with both student and farmer; but there was always about him a certain brusqueness and an aloofness from the common world which made him impatient of trivialities; nor did he suffer fools gladly. He was a splendid field naturalist, loving wild things and wild and lonely places, and it was this passion that, in his earlier years, took him to remote Scandinavia to dwell for months among the Lapps, and later compelled him to the Alps and the Pyrenees, to the Welsh mountains, and ever and again to his own beloved Yorkshire dales.

John Percival was an eminent scientist who, perhaps, received more recognition in other countries than in his own, and in his passing, agricultural science has lost a memorable figure.

WILLIAM B. BRIERLEY

Dr. M. C. Rayner

BY the sudden death of Dr. M. C. Rayner, on December 17, British mycology has sustained a serious loss. Up to the last moment she had been pursuing her researches into the mycorrhizal habit in plants, and, in fact, died only a few hours after visiting her experimental plots at Wareham Heath in Dorset. Relatively early in her career, Dr. Rayner had established herself as unquestionably the leading British authority on the subject of mycotrophy in plants—a position which she afterwards consolidated both by the volume of her own research, and by the breadth of her interests in her chosen field of work.

Dr. Rayner's interest in the mycorrhizal habit, and her scientific collaboration with Prof. W. Neilson Jones, to whom she was married in 1912, both started in 1910 with an inquiry into the ecology of *Calluna vulgaris* on the Wiltshire and Berkshire Downs. This investigation led a few years later to the publication of a now classical paper for which she was awarded the degree of D.Sc. by the University of London, on "Obligate Symbiosis in *Calluna vulgaris*". In this paper she established in great detail the nature and extent of the association between *C. vulgaris* and its fungus endophyte, *Phoma radicis callunæ*. Numerous other papers on the endophytic mycorrhiza of heath plants followed, and in 1927 she published her monograph on "Mycorrhiza", as a *New Phytologist* reprint; more than twenty years later, this monograph is still an invaluable work of reference, as well as a pleasure to read.

As a result of a discussion in Bagley Wood, Oxford, on the occasion of the British Association meeting in 1926, Dr. Rayner started work on the other large group of mycorrhizal fungi, the ectophyte associates of forest tree roots. This led both to some most interesting fundamental work on the nature of ectophytic mycorrhiza, and to the solution of an important practical problem—the establishment of young conifers on the Wareham Heath area of Dorset, a difficulty that had for some time vexed the Forestry Commission. Later the Commission provided Dr. Rayner with a research nursery and a scientific helper to assist her investigations at Wareham and elsewhere. Dr. Rayner's series of papers on these tree investigations, together with other contributions by herself and Prof. Neilson Jones, were reprinted in 1944 by Messrs. Faber and Faber in a single volume under the title "Problems in Tree Nutrition"—an indication of the wide interest aroused by this work. In recent reports, Dr. Rayner has stressed the importance not only of the compost but also of the system of cultivation used in conjunction with it, for the promotion of maximum fungal activity and for the maintenance of soil fertility in the forest nurseries. Dr. Rayner's precise interpretation of her results on the Wareham Heath plots is still a subject for controversy and further experiment; none would deny, however, that by her striking demonstration of the value of organic composts for the establishment of coniferous seedlings she has been an outstanding benefactor to forestry.

At times, Dr. Rayner was wont to deplore the controversy, not infrequently bitter, that has always ranged around the subject of mycorrhiza, and in which, during her life, she was well to the forefront. Partly as a result of her own work, however, the benefit to the host of the ectophytic mycorrhizal association is now established almost beyond question, even though its mechanism still requires further elucidation. The benefit derived from the endophytic mycorrhizal habit, by heath plants, orchids and others, on which Dr. Rayner insisted so strenuously, has always been harder to prove; for a long time, the crucial experiment always seemed to be just beyond the grasp of investigators, but recent work suggests that the fungus endophyte may bring about the successful establishment of its seedling host by supplying missing growth factors, as well as by rendering biochemical assistance in other ways, perhaps.

In recent years, Dr. Rayner extended her interests to embrace mycorrhizal associations in a great variety of crops, tropical as well as temperate, and travelled widely in pursuit of her work. To those who knew her well she could be a delightful and stimulating companion, whether in the laboratory or the field, and a visit to her laboratory at Bedford College always gave one plenty to think about. Her long scientific collaboration with her husband, Prof. Neilson Jones, in which temperaments and interests were most happily blended, was a very fruitful one; right up to the last, she had refused to give in to chronic ill-health, and her determination to continue with her work at all costs gained the admiration of all who knew her.

S. D. GARRETT

Mr. G. E. F. Fertel

GEOFFREY FERTEL was born on November 19, 1913, at Bromley, Kent, where his father, who was of Huguenot ancestry, was well known for his musical ability and was organist at the parish church; his maternal grandfather, Benjamin Harrison, was distinguished as an archæologist. While still a small child, he showed unusual interest in natural things and in mechanisms; his love of the countryside was encouraged by his Kentish environment, and at Sevenoaks School he was allowed to spend time on botany instead of games, for which he had no liking.

On entering the Imperial College of Science and Technology, London, Fertel decided to study physics, and was soon recognized as a quick and ingenious constructor and experimenter. Though an indefatigable inquisitor of his teachers, Fertel was never happy until he had 'seen through' a mechanism or a problem in his own way, which usually involved an analogy with some other mechanism or problem, often in another branch of science. He had little interest in formal science, and less in formal people.

After graduation, he remained at the College as a research student, taking part in developing the new technique of time-of-flight measurements with slow neutrons. He left not long before the outbreak of war to join the physics staff of the University of Bristol; but there was already no doubt that his great ability to make apparatus work was matched by a power to see clearly the right technical method to apply to any particular scientific problem. At this time, too, his devotion to scientific things began to leave room for personal friendships that grew in number and strength as time went on. He became noted for original demonstration experiments and for technical jokes such as the perfectly constructed left-handed wood-screw kept in his pocket to hand to a colleague in need, with a right-handed one in the other pocket to be offered as soon as the joke had been enjoyed.

During the War, Fertel worked in the Admiralty Signals Establishment, where his talent for understanding and making things yielded several devices, of which at least one is still an essential part of Service radar equipment. He was glad to return to university life at Bristol and took part in many activities, not only in the laboratory but also in such pursuits as the exploration of caves, both in England and on the Continent. He left Bristol in 1948 to join in the construction and operation of the large cyclotron at the University of Birmingham, and quickly gained the admiration and the affection of his new colleagues. On January 19, 1949, while making adjustments to the cyclotron, he was electrocuted and died instantly.

Fertel left little published work, but will long be remembered as a man of extraordinary energy and skill whose passion was to know and to understand.

NEWS and VIEWS

Botany at Delhi: Prof. P. Maheshwari

Dr. Panchanan Maheshwari, who is well known for his work on angiosperm embryology and cytogenetics, has been appointed to a chair of botany in the University of Delhi. Receiving his early training at Allahabad, he came under the influence of an American botanist, the late Dr. Winfield Dudgeon, and in 1931 was the first to obtain the degree of D.Sc. in botany in the University of Allahabad. As a teacher he served successively as a lecturer and associate professor of botany at Agra College (1930–37). For about two years (1937–39) he was lecturer in the University of Allahabad and for a brief term in Lucknow, later migrating to Dacca as reader in botany and head of the department, where he developed facilities for postgraduate teaching and research. He was recently promoted professor of botany in the University of Dacca and became dean of the Faculty of Science.

Prof. Maheshwari has travelled widely for the sake of developing contacts with colleagues in his own field of research, undertaking two long study tours in Europe (1936–37) and in the United States (1945–47). His original work has been largely influenced by the school of Tischler at Kiel and of Schnarf in Vienna. He has done much, both directly and indirectly, to advance the study of angiosperm embryology in India. He is the author of an advanced text-book on the "Embryology of Angiosperms", which is shortly to be published, and is editing for the *Chronica Botanica* series a "Manual of Angiosperm Embryology" based upon contributions from specialists in many countries of the world. He is president elect of the Section of Botany at the next Indian Science Congress to be held in Poona in January 1950.

Nature Conservancy in Britain

Mr. Herbert Morrison announced in the House of Commons on February 11 that arrangements have been completed for forming a Nature Conservancy, and that a separate committee will supervise activities in Scotland. Membership of the Conservancy will be as follows: Prof. A. G. Tansley (chairman); Mr. A. Anderson, M.P.; Mr. C. Elton; Dr. E. B. Ford; Dr. H. Godwin; Mr. E. H. Keeling, M.P.; Mr. N. B. Kinnear; Prof. R. C. McLean; Prof. J. R. Matthews; Mr. E. M. Nicholson; Prof. W. H. Pearsall; Mr. M. Phillips Price, M.P.; Mr. J. A. Steers; Mr. W. L. Taylor; and Dr. A. E. Trueman. The Conservancy—Mr. Morrison referred to the term as a more convenient title than conservation board—will be responsible for the whole of Great Britain; but as a result of the recommendations of the Scottish Wild Life Conservation Committee, and of consultations with the Secretary of State, activities in Scotland will be supervised by a Scottish committee with the following composition: Prof. J. R. Matthews (chairman); Mr. A. Anderson, M.P.; Mr. H. C. Beresford-Peirse; Dr. F. Fraser Darling; Mr. A. B. Duncan; Dr. D. N. McArthur; Sir Basil H. H. Neven-Spence, M.P.; Prof. A. D. Peacock; Prof. J. Ritchie; Prof. J. Walton; Lord Wemyss and March; and Prof. C. M. Yonge.

Dr. John Berry, who is known for his work in fishery research and for contributions on wild life in Britain, and in 1944 was appointed biologist to the North of Scotland Hydro-Electric Board, has been released to serve as director for Scotland of the Conservancy. It has already been announced that Captain Cyril Diver has been appointed as director-general, with his office at Thorney House, Smith Square, S.W.1. The Conservancy is seeking a charter on similar lines to that of the Agricultural Research Council, with which it will co-operate. The Committee of the Privy Council for Agricultural Research will be reconstituted as the Committee of the Privy Council for Agricultural Research and Nature Conservation, and the Minister of Town and Country Planning will join it in view of its extended responsibilities. The Conservancy will start work at once.

Institution of Mechanical Engineers: James Clayton Prize

The Council of the Institution of Mechanical Engineers has awarded the 1948 James Clayton Prize of £1,350 to Mr. Karl Baumann, for his contributions to the advancement of mechanical engineering science by way of invention, design and investigation, communicated, in part, in a lecture delivered to the Institution in 1948. Mr. K. Baumann is the chief mechanical engineer and a director of the Metropolitan-Vickers Electrical Co., Ltd., Manchester. His professional life has been largely identified with the development of the modern steam power station including steam turbines and boiler plant, and latterly the internal combustion turbine. He received the Institution's premier award, the Thomas Hawksley Gold Medal, for a paper published in 1930. The James Clayton Bequest is for the distribution annually, on research, investigation and the encouragement of mechanical engineering science, of three-quarters of the income of the fund. The remaining quarter of the income is for the award (James Clayton Prize) to a member, associate member, graduate or student of the Institution, who contributes most in the year to modern mechanical engineering science. Previous awards have been made to Sir Frank Whittle (1945), Mr. Hayne Constant (1946), Sir Richard Southwell (1946), Mr. T. E. Beacham (1947), and Mr. J. E. Sears (1947).

Midwest Research Institute

Dr. George E. Ziegler has been appointed director and Dr. Clayton O. Dohrenwend assistant director of the Midwest Research Institute, Kansas City. Dr. Ziegler went to the Institute at the time of its inception in 1945 as executive scientist, having previously been associated with the Armour Research Foundation in Chicago. He is known in scientific circles for his experimental X-ray diffraction studies, and has been acting chief administrator of the Institute since the resignation of Harold Vagtborg some six months ago. Dr. Dohrenwend has been research consultant since going to the Institute in July 1946. He was formerly associated with the Illinois Institute of Technology as director of the Mechanics Department. He is a specialist in the field of engineering mechanics and past president of the Society for Experimental Stress Analysis.

East African Industrial Research Board

The fifth annual report of the East African Industrial Research Board (Pp. iii+28. Nairobi, P.O. Box 1587. 1*s*. 6*d*.), covering the year ended December 31, 1947, includes the report of the acting chairman, Mr. H. B. Stent, the General Laboratory report, the annual report of the Tanganyika Industrial Committee, 1947, and a list of publications on industrial research in East Africa. A departmental report on ceramics details the work carried out on bricks and roofing tiles, domestic pottery, refractories, building materials, glazed wall-tiles and drain-pipes, while a fairly full account is given of work on the extraction of undried pyrethrum flowers, which has given results comparing favourably with existing methods of extracting dried flowers and appears to merit large-scale trials. Work on silicophosphate is also described in detail, including the results of rotary kiln firings, laboratory-scale firings, and of investigations on the fractions of the clinker soluble in water and in citric acid. Investigations on the treatment of effluents from the processing of sisal and coffee have continued, and biological filtration gave promising results for the former. The Tanganyika Industrial Committee reports on the production of totaquina, the final target of 10,000 lb. for which was met early in November, 1947. Other investigations under the Committee related to the assay and manufacture of papain, and the assay and cultivation of pyrethrum flowers. The Board itself at its three meetings during the year focused its attention on negotiations for the early establishment of a permanent East African Scientific and Industrial Research Organisation, and a memorandum was submitted to the East African Governments and to the Colonial Office advocating the establishment of such an Organisation on the lines of other existing inter-territorial research organisations. Stress was laid on the vital need of such work if the large sums of money for the development of the East African territories are to be used to the best advantage.

Parliamentary and Scientific Committee

The annual report for 1948 of the Parliamentary and Scientific Committee records the visit of a deputation from the Committee to discuss with the Minister of Education the position in Britain of colleges of technology. The Minister said that the report of the Committee agreed closely with the policy of the Ministry; but he thought that a National Council of Technology would be too cumbersome. He agreed that the status of technical colleges should be raised, and promised to increase the number of technical State Scholarships immediately the demand and capacity to take advantage of such scholarships existed. Members of the Committee took a very active part in debates on the Development of Inventions Bill, and a critical discussion of the Bill was arranged on May 11. Early in the year a detailed memorandum on current difficulties in the import of scientific books and periodicals was submitted to the Board of Trade, and information collected from scientific bodies about the shortage of paper and facilities for producing scientific books and periodicals was incorporated in a memorandum forwarded to the Lord President of the Council in July. A reply from the Lord President in September stated that the paper allocation for the production of books was practically equal to that used in 1939 and that about double the number of books were being produced. A further memorandum, which, among other recommendations, urged that the criteria to be applied should be whether the output was meeting the greatly increased requirements in Great Britain and overseas for up-to-date scientific and technical information, and not pre-war figures, was submitted to the Lord President in November. A memorandum on steel utilization has also been prepared by the Committee; technical education, the salaries of teaching and research staff in medical schools and universities, and the Veterinary Surgeons Bill have also been considered.

Superconducting Bolometers

During the past few years a sensitive form of bolometer has been developed, at the Johns Hopkins Cryogenic Laboratory, under the direction of Dr. D. H. Andrewes, which makes use of the high variation of electrical resistance with temperature that occurs in the region between the normal- and zero-resistance states of a superconducting material. Tantalum (*Rev. Sci. Instr.*, 13, 281; 1942) has been used successfully, but it requires to be cooled to liquid helium temperatures. Columbium nitride, with a transition temperature at about 15° K., just above the triple point of hydrogen, presents a much less difficult temperature-control problem, and bolometers of very high sensitivity have been made. These should prove useful for the examination of the as yet unexplored region of emission spectra of sources at room temperature, with considerable application in biological research. Recently, a careful study of the infra-red sensitivity of a number of columbium nitride superconducting bolometers has been made by N. Fuson (*J. Opt. Soc. Amer.*, 38, 845; 1948), and the sensitivities have been compared with those of other infra-red detectors. Details of the construction of the bolometers, of the infra-red source, modulator, cryostat, wide-band amplifier, and other auxiliary equipment, together with the experimental procedure, are given. Time constants of 0·7 to 17·0 milliseconds were observed. For the purposes of comparison, a factor of merit, based on the reference conditions suggested by R. C. Jones (*J. Opt. Soc. Amer.*, 37, 888; 1947) and R. Havens (*J. Opt. Soc. Amer.*, 36, 355 A; 1946), is defined. The nine most sensitive of the twenty-five superconducting bolometers examined had factors of merit between 1·3 and 14·0.

Functional Embryology

The New York Academy of Sciences has issued a publication entitled "Recent Studies in the Mechanisms of Embryonic Development" (*Ann. New York Acad. Sci.*, 49; 1948) the title of which is self-explanatory. It contains nine contributions by separate authors each dealing with one aspect of the general subject, and each article is well illustrated and provided with a brief summary of the relevant work and a bibliography. The subjects dealt with include: the early organisation and differentiation of prospective areas in the developing eggs of *Nereis*, the amphibians *Triton* and *Ambystoma*, and the chick; biochemical differentiation; the role of nerves in amphibian limb regeneration; and locomotor responses and retinal development in normal and transplanted retinæ. Incidentally the name '*Amblystoma*' is used in two of the papers instead of the correct form *Ambystoma*. It is difficult to pick out for special notice any one paper; but that by S. R. Detwiler on "Quantitative Studies on Locomotor Responses in Amblystoma Larvæ following Surgical Alterations in the Nervous System" with its reconstructions is of particular interest in view of the recently published book by C. Judson Herrick on the brain of *Ambystoma*.

National Tsing Hua University: Science Reports

The three series of the *Science Reports of the National Tsing Hua University* (Series A: mathematics, physics and engineering; Series B: biology and psychology; Series C: geology, geography and meteorology), published for several years before 1937, were suspended during 1937–45, with the exception of one issue of Series A printed in September 1940. With the return of the University to Peiping, publication of the three series has been resumed, and, so far, two issues of Series A (**4**, Nos. 4, 5 and 6; 1947, and **5**, No. 1; 1948) have been received. The papers appearing in the 1947 issue were originally intended for publication in 1941 to commemorate the thirtieth anniversary of the University (1911–41); but, although the University was then at its war-time home at Kunming, the *Reports* were being printed in Shanghai, which was overrun by the Japanese military forces, and therefore they could not be published. The *Reports*, which are in English or French, indicate clearly how, in spite of extremely trying conditions, research work of a high standard continued to be carried out in the University.

Melbourne Seismological Station

THE Council of the University of Melbourne recently approved an arrangement whereby the seismograph of the former Melbourne Observatory, which the University accepted from the Government of Victoria when the Observatory was disbanded in 1941, will in future be in the care of the Department of Geology of the University. A member of staff of the Geology School (Mr. A. J. Gaskin) has been nominated seismologist, and a technical assistant provided for him. It is hoped that the issuing of seismological bulletins will be commenced in June 1949, and that the issue will thereafter be at regular intervals, probably quarterly. Instrumentation remains unchanged for the present. All records later than those listed in the last leaflet issued for the Observatory (July 2, 1940) have been inspected, and information regarding them may be obtained on application. Correspondence (including requests for the receipt of bulletins) should now be addressed to the Seismologist, Department of Geology, University of Melbourne, Carlton, N.3, Victoria, Australia.

Sir D'Arcy Thompson: Commemoration Fund

SOME of the many friends and pupils of the late Sir D'Arcy Thompson have issued an appeal for contributions to a commemoration fund which will be used for the following purposes: (1) presentation of a bronze head to the University of St. Andrews; (2) presentation of a portrait in oils to University College, Dundee; (3) memorial prizes in the Departments of Natural History at St. Andrews and Dundee. The printed announcement of the fund contains excellent reproductions of the portrait and of the clay model of the head. It has not been possible to communicate personally with all of Sir D'Arcy Thompson's friends, but copies of the announcement may be obtained from the Secretary of the Fund, D. R. R. Burt, Department of Natural History, the University of St. Andrews.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: D. Leuchars, assistant conservator of forests, Uganda; E. Q. O'B. Smith, assistant conservator of forests, Northern Rhodesia; D. A. Aitkenhead, geologist, Gold Coast; C. Facer, surveyor, Uganda; K. T. Pugh, surveyor, Tanganyika; A. H. Ward, surveyor, Northern Rhodesia; S. E. Brinkman, meteorological assistant, East African High Commission; F. J. Cornish, meteorological assistant, East African High Commission; A. P. Johnson, assistant meteorologist, Nigeria; E. B. Powell, assistant controller (radio), Federation of Malaya; C. J. M. Simpson, entomologist, East African High Commission; S. D. Ross (principal agricultural officer, Nigeria), assistant director of agriculture, Nigeria; F. W. Roe (geologist, Federation of Malaya), chief geologist, Borneo; H. R. Binns (deputy director of veterinary services, Palestine), scientific officer, East African Veterinary Research Organisation; R. M. Gambles (veterinary officer, Cyprus), senior veterinary research officer, Nigeria; R. E. Gould (senior poultry and bee-keeping officer, Palestine), fisheries officer, Tanganyika; W. D. Silvera (medical officer, Jamaica), senior lecturer in pathology, University College, Ibadan, Nigeria.

Announcements

THE following appointments have been made in the University of London: Mr. F. Wormald, to the University chair of palæography tenable at King's College as from January 1, 1950. Dr. G. L. Brown, of the National Institute for Medical Research, to the Jodrell chair of physiology tenable at University College as from October 1, 1949. The title of professor of logic and scientific method in the University has been conferred on Dr. K. R. Popper in respect of the post held by him at the London School of Economics.

THE Brewster Gold Medal of the American Ornithologists' Union has been awarded to David Lack, director of the Edward Grey Institute of Field Ornithology at Oxford, for his book "Darwin's Finches", published in 1947 by the Cambridge University Press. The Medal is awarded for the most important work relating to the birds of the western hemisphere published during the preceding six years.

IN co-operation with the University of Edinburgh and the East of Scotland College of Agriculture, the Association of Agriculture is arranging a Conference, intended primarily for teachers, on "Applied Biology, Geography and Education" at the College of Agriculture, 13 George Square, Edinburgh, during April 12–14, 1949. The registration fee is 2*s.* 6*d.*, which includes the inaugural dinner, and tickets and further details may be had on application to Alexander Hay, General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1.

APPLICATIONS are invited for Lady Tata Memorial Fund grants and scholarships to scientific workers of any nationality for research in diseases of the blood, with special reference to leukæmia, in the year beginning October 1, 1949. Grants are made for research expenses, and scholarships are awarded as personal remuneration, their normal value being £400 per annum for whole-time research, or less for part-time work. Applications must be submitted before March 31, 1949, and the awards will be announced in June. Further particulars and forms of application may be obtained from the Secretary of the Scientific Advisory Committee, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

ERRATUM.—Referring to his communication entitled "*Trypanosoma heptatretæ* sp.n., a Blood Parasite of the Hagfish" (*Nature*, **161**, 440; 1948), Mr. Marshall Laird has written proposing amending the name to *T. heptatreti* in accordance with the International Rules of Zoological Nomenclature.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Electron Microscope Study of the Nuclear Membrane

THE giant nuclei of full-grown oocytes of Amphibia offer unique opportunities for anatomical and physiological study, on account of the relative ease with which they may be isolated and handled. The material for the present study was obtained from *Triturus cristatus* and *Xenopus lævis*.

Under a low-power binocular, the nuclei are isolated into distilled water with the aid of needle and forceps. In this medium the nucleus rapidly swells, and meanwhile adhering cytoplasmic materials may be pumped away by means of a pipette. The entire nucleus, freed from cytoplasm, is then transferred to fresh distilled water: a copper specimen grid is now placed in the same container, and the nuclear membrane ruptured and stretched out over the grid by means of a pair of fine-pointed tungsten needles. After the stretched membranes have been pumped free from nuclear sap, they may be dried directly or after prior fixation. For the preservation of fine structure, fixation appears to be necessary.

Grids carrying nuclear membranes were examined in a Siemen's electron microscope operating at 52 kV., the magnification of the photographic negative being 12,000–15,000 diameters. The photographs, three of which accompany the present letter, indicate that the nuclear membrane is a compound structure. One component is a porous sheet, the pores being approximately 300 A. in diameter in hexagonal array, with a repetition distance of about 800 A. It must be borne in mind, however, that the membranes are readily distorted during preparation, the hexagonal arrangements being frequently disturbed. The other component is a membrane with no evident fine structure. This closely over- or underlies the porous membrane; but the relative positions of the two are not yet known. Under certain as yet ill-defined conditions, the porous membrane disintegrates in the process of specimen preparation, leaving the structureless membrane only.

It may be presumed that the structureless component determines the permeability properties of the nuclear membrane. Other investigations have shown that egg albumen cannot penetrate this membrane, and hence even if a porous structure is present it would be beyond the limits of resolution of the existing microscope. The visibly porous membrane, on the other hand, probably acts merely as a mechanical support for the structureless membrane.

This work is being continued, and a detailed account will be published elsewhere.

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X-Ray Diffraction Study of the Structure of Bacterial Flagella

FOLLOWING on the demonstration by Gard[1] of the practicability of obtaining the flagella from bacterial cultures in fair yields and in a highly purified state more detailed chemical and physicochemical investigations are now being undertaken under a scheme supported by the Swedish Natural Science Research Council. Data have already been published by Weibull and Tiselius[2] on the flagellar material prepared by Gard from *Salmonella paratyphi* B., and by Weibull[3] on the flagella of the harmless and easily cultivated *Proteus vulgaris*. The present communication is a preliminary account of an X-ray diffraction study of flagellar material prepared at Uppsala and brought to Leeds.

We have so far examined the flagella of *Proteus vulgaris* and *B. subtilis*. The method of preparation was as already described[3]; here we need only say that the final product from *Proteus*, for example, forms a colourless stable viscous solution with strong flow birefringence. It gives a precipitation reaction with a *Proteus* × 19 *H* rabbit antiserum, has a nitrogen content of 15·7–16·1 per cent, shows only traces of phosphorus and 1 per cent carbohydrate at the most, and contains no tryptophane and no purine or pyrimidine bases: it has the characteristics of a protein but not of a nucleoprotein. When examined in the electron microscope, essentially only one structural element is seen—long flexible threads of the same thickness as the flagella on the bacterium, but shorter, presumably owing to breakage during the purification process.

The flagella are also reversibly precipitable with ammonium sulphate and show electrophoretic mobility; in brief, they behave like long macromolecules and therefore invite X-ray study by just those tech-

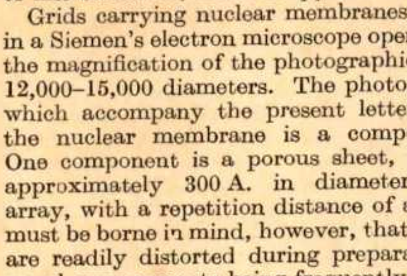

Fig. 1

Fig. 1. *Triturus cristatus*. The porous sheet component of the nuclear membrane after fixation with osmium tetroxide. Magnification 34,000 diameters

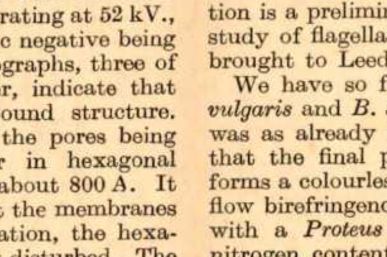

Fig. 2

Fig. 2. *Triturus cristatus*. The structureless sheet component of the nuclear membrane after fixation with osmium tetroxide. Magnification 34,000 diameters

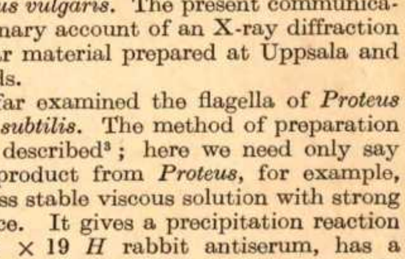

Fig. 3

Fig. 3. *Xenopus lævis*. Portion of nuclear membrane fixed with phosphotungstic acid. Magnification 27,000 diameters

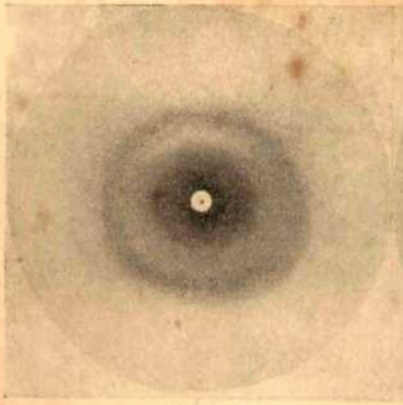

Fig. 1

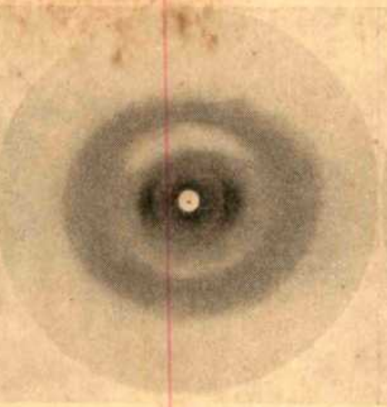

Fig. 2

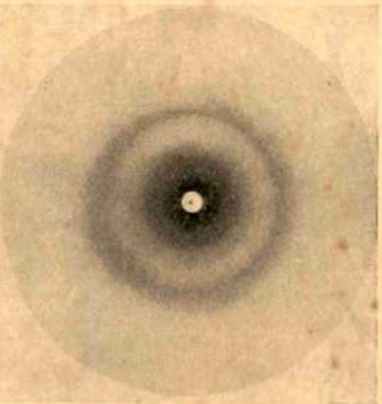

Fig. 3

Fig. 1. X-Ray fibre diagram given by thin film of flagella of *Proteus vulgaris* photographed with the beam parallel to the plane of the film. (Plane of film parallel to long edge of page)

Fig. 2. Same as Fig. 1, but for *B. subtilis*

Fig. 3. Partial β-diagram obtained after squeezing moist film of *Proteus* flagella between pieces of plate glass

niques that we have evolved for myosin, sodium thymonucleate, and many other similar preparations. In these preliminary experiments we have simply made very thin films by allowing small pools of the viscous solution to dry on microscope slides previously treated with dichloro-dimethyl-silane to make them water-repellent. The films were then easily detached, and specimens suitable for X-ray examination were built up from several strips lying flat on top of one another. It should be emphasized that the drying process causes no significant deterioration: the films could be redissolved in water and the solution still showed flow birefringence.

When the solution is dried to a thin film the flagella are brought to lie approximately in one plane, and a pseudo-fibre diagram should be obtained when the X-ray beam is parallel to this plane. Figs. 1 and 2 illustrate two of the photographs we have obtained in this way. Detailed analysis will be given later (in any case the experiments are still proceeding with the view of getting better orientation and higher resolution), but already it may be stated that the diagrams conform in the main to the α-type characteristic of the great family of elastic fibrous proteins that we have called the keratin–myosin–epidermis–fibrinogen group[4]. Not only is the now well-known meridional reflexion at about 5·1 A. clearly in evidence, but also there are at least half a dozen other reflexions that find their counterparts in hair and muscle photographs and particularly in MacArthur's high-resolution diagram of porcupine quill[5]. In addition, we have succeeded in stretching *Proteus* flagella into the β-form—not as yet by direct pulling, to be sure, but by squeezing moist film at room temperature between pieces of plate glass, after the procedure found effective with myosin[6], for example. In our experiments so far, the resulting squeezed film was too fragile to mount intact for the purpose of taking an X-ray photograph with the beam parallel to the surface, and we have had to be content with a powder photograph (Fig. 3); but there is no doubt that the diagram reveals appreciable transformation into protein of the β-type; it is, in fact, very like what is found after heating the flagella to about 100° (cf. myosin again).

It follows that, from the X-ray point of view at least, the flagella on *Proteus* and *B. subtilis* are of the nature of primitive hairs or muscles—and it is not of basic importance which name is used, since X-ray and related studies indicate that the whole of the keratin–myosin–epidermis–fibrinogen group is derived from a single master plan[4]. From electron micrographs taken at Leeds of *Proteus* flagella and tobacco mosaic virus in the same field, it is seen that the former (when dry) are definitely the thinner of the two; their thickness is about four-fifths or five-sixths that of the virus particles (150 A.)—say, roughly, 120 A. Conceivably, therefore, these flagella may even be described as 'monomolecular' hairs or muscles, for their thickness falls within the order of size of the largest side-spacings[5,7,8] that have been observed or inferred for other members of the keratin–myosin–epidermis–fibrinogen group; and besides, there is a rather surprising detail and sharpness about the photographs which suggests a structural simplification as compared with hair keratin, for example. There are reasons for thinking that the latter is a polyphase system built of polypeptide grids (or combinations of grids) of similar form but varying amino-acid constitution[5,9]; but it may be that the framework of a flagellum is constructed from only one such type of component.

At all events, it is clear that a most promising new field is opened up, with a new approach to the mechanics of protein structures and probably fresh light on the problem of the muscle machine. We are strengthened in this last suggestion by the curious fact that though the normal flagella diffraction diagram, as stated above, is composed mainly of reflexions conforming to the α-form of the keratin–myosin–epidermis–fibrinogen group, what appears to be the characteristic backbone reflexion of the β-form is also present, and indeed not in its usual position on the equator, *but on the meridian*. Such a transposition was observed some years ago by Rudall[10] in supercontracted preparations of epidermis, myosin, fibrinogen and fibrin, and he interpreted it as direct experimental evidence in support of the suggestion[4] that the α-form may shorten simply by developing longer transverse folds. If Rudall's interpretation is correct—and there is a great deal to be said for it—then it is tempting to suppose that the flagella diffraction diagram reveals also a partial state of contraction.

We should like to express our indebtedness to Mr. E. Beighton for his skilful aid in taking the X-ray

photographs, and to Dr. R. Reed and Mr. A. Millard for the electron micrographs of *Proteus* plus tobacco mosaic virus, also to Profs. Gard and Tiselius our appreciation of their encouraging interest. One of us (C. W.) would also wish to thank the Swedish Natural Science Research Council for a grant enabling him to take part in the investigation.

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University of Uppsala.
Jan. 5.

[1] Gard, S., *Arkiv för Kemi*, **19**, A, No. 21 (1944).
[2] Weibull, C., and Tiselius, A., *Arkiv för Kemi*, **20**, B, No. 3 (1945).
[3] Weibull, C., *Biochim. et Biophys. Acta*, **2**, 351 (1948).
[4] See, for example, Astbury, W. T., Croonian Lecture (1945), *Proc. Roy. Soc.*, B, **134**, 303 (1947); also many communications in *Nature*.
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[7] Bear, R. S., *J. Amer. Chem. Soc.*, **66**, 2043 (1944).
[8] Kratky, O., Sekora, A., and Weber, H. H., *Naturwiss.*, **31**, 91 (1943).
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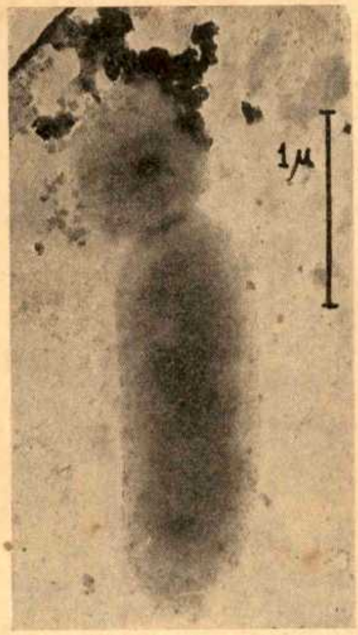
Sectioning of the Bacterial Cell for the Electron Microscope

The introduction of a technique for cutting ultra-thin sections of biological tissue with the conventional microtome[1] has also made feasible the sectioning of isolated cells for the electron microscope. Bacterial cells were chosen as a first example because of convenient size, ease of handling in large numbers, and because of the intrinsic importance of any new approach to the problems of bacterial morphology.

B. megatherium was grown on nutrient agar, and when the culture was approximately twenty-four hours old, quantities of cells were transferred with a wire loop to a 5 per cent formalin solution in a centrifuge tube. After one hour of fixation the cells were centrifuged for five minutes at 20,000 r.p.m. and the formalin then poured off. Dehydration with a graded series of alcohols was then carried out, using the centrifuge to keep the bacteria together in the transition from one solution to another. Impregnation with Mallinckrodt 'Parlodion' followed, starting with 3 per cent 'Parlodion' in equal parts of ether-alcohol and ending in a 12 per cent solution. Transition from 6 to 12 per cent 'Parlodion' was accomplished by evaporation of the solvent. After one day in 12 per cent 'Parlodion', chloroform was used as a hardening agent, after which the hardened block was broken out of the centrifuge tube. Impregnation of the block with paraffin (m.p. 65°) followed, after going through a carbol-xylol bath to remove the last traces of water. The doubly embedded block was finally mounted on a plastic pillar which could be clamped in the microtome.

·1μ One-tenth micron sections were cut as described in ref. 1, and were flattened on a microscope slide, using needles under a binocular dissecting microscope. The paraffin was removed with benzol, after which the slide was dipped vertically into a beaker of dilute (0·2 per cent) collodion in amyl acetate. This replaced the original collodion with a thinner and more homogeneous film, which was then floated off on a clean water surface. Microscope specimen screens (200 mesh) were placed on the sections and the entire film inverted and mounted on another slide. After drying, the specimens were ready for examination in the electron microscope.



Transverse and longitudinal sections of *B. megatherium* approximately 0·1 microns thick. × 25,000; 50 kV. Note similar density and detail in the two cells

Since the cells were oriented at random in the block, the sections might be expected to show cells cut at various angles. The accompanying photograph shows two cells which were nearly at right angles in the block, giving rise to a longitudinal and a transverse cut in the same field of view. Sufficient internal detail is visible in both cells to make it clear that the sections are adequately thin for effective use with a 50-kV. electron microscope. Much further work will, of course, be necessary to establish the significance of the internal detail observed in an experiment of this type. It is the purpose of this note merely to describe a new technique, which may profitably be used in the study of bacterial morphology and the relationships of bacteria and bacterial viruses.

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Daniel C. Pease
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University of Southern California,
Los Angeles, California.
Nov. 24.

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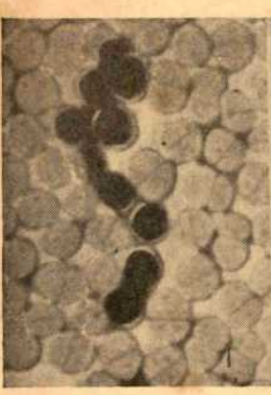
[1] Pease, D. C., and Baker, R. F., *Proc. Soc. Exper. Biol. and Med.*, **67** (4), 470 (April 1948).

A Method of Sectioning Bacteria *in situ* for Electron-microscopical and Cytochemical Investigations

A method has been developed for preparing sections of bacterial cells for observation with the electron microscope. An impression preparation of a young growing culture is made on a polished glass surface and fixed with osmic acid. On to this a beryllium film is evaporated by means of Hast's method[1]. The beryllium film is then stripped from the glass surface and frequently carries with it a section through the bacterial cells with their relationships undisturbed. During the evaporation of the beryllium, some atoms of the metal penetrate the surface of the cells, thus anchoring a layer of the bacterial cytoplasm to the film. This layer is normally removed when the film is stripped, although sometimes whole cells adhere to the film as shown in Fig. 1. The process can be repeated and a further section of the same group of cells obtained. Fig. 2 shows such a section from a young and rapidly dividing culture of Enterococci (*Str. fœcalis*). The cell appears to contain a round, well-defined body which seems to divide at the same time as the cell. It is further possible to treat the sectioned bacteria with agents (such as enzymes or antibodies) and to re-examine the sections on the beryllium film. The section can be washed with buffers and digested with enzyme preparations. It should thus be possible to combine this technique with cytochemical investigation. The result of such studies will be described in a further communication.



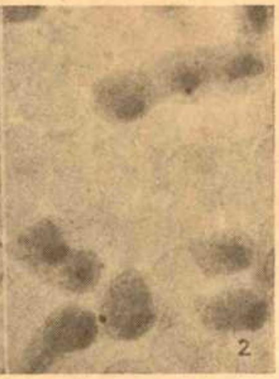


Fig. 1. Surface section through Enterococci (5-hr. culture). × *c.* 9,000

Fig. 2. Third section through Enterococci (5-hr. culture). × *c.* 12,000

I am deeply indebted to Prof. M. Siegbahn, who has constructed the microscope with which the pictures were taken and who has placed all facilities at my disposal, and to Prof. N. Hast, who encouraged me to use the beryllium as supporting membrane. The photographs were taken by Mr. Rosenquist.

A. HELGE F. LAURELL

Nobel Institute for Physics,
Stockholm 50. Aug. 1948.

[1] Hast, *Nature*, **159**, 354 and 370 (1947).

Polarization of Radiation from Distant Stars by the Interstellar Medium

PHOTOMETRIC observations for the detection of partially polarized radiation from eclipsing binary stars have been in progress at Yerkes Observatory, of the University of Chicago, for several years with the view of establishing observationally the effect pointed out by Chandrasekhar that the continuous radiation of early-type stars should be polarized[1,2]. On the assumption that the opacity of early-type stars is due to scattering by electrons, the continuous radiation emerging from a star should be polarized with a maximum of polarization of 11 per cent at the limb. Since the presence of this polarization can be detected only when the early-type star is partially eclipsed by a larger late-type companion of the system, the effect is masked by radiation from this companion, so that the expected maximum observable effect is only of the order of 1·2 per cent in the one case investigated (*RY* Persei).

However, the observations made in connexion with this problem have led to the detection of a new phenomenon which appears to have a bearing on the constitution of interstellar matter. Three Wolf–Rayet spectroscopic binaries (two of which are known to be eclipsing) in Cepheus were observed with the following results:

Star	Polarization	
	Per cent	Position angle
CQ Cep.	10·0	62
BD + 55° 2721	8·0	44
WN Anon*	12·5	44

* No catalogue number.

If the polarization were associated with the individual stellar systems, there should be a change in the polarization, in position angle and amount, with the phase of the binary motion. However, no such change was observed. In order to determine possible systematic errors in the receiving equipment, I investigated the polarization of comparison or control stars of similar colour and brightness. With the exception of *BD* + 55° 2723, no significant polarization was found in the control stars. *BD* + 55° 2723 gave 3 per cent polarization with a position angle of 44°. This particular star differs from the other control stars in that it is a giant, and is consequently more distant than the other control stars, which belong to the main sequence.

Similar observations were made on a group of Wolf–Rayet stars in Cygnus, which showed no significant polarization, while two stars in Scutum gave positive results. Other regions, such as the double cluster in Perseus, also show polarization with values ranging up to 12 per cent.

We conclude from the positive and negative results quoted that the measured polarization does not arise in the atmosphere of these stars, but must have been introduced by the intervening interstellar medium. If this conclusion is accepted, a new factor in the study of interstellar clouds is introduced. Further observations are in progress for relating this phenomenon with other observable characteristics of the interstellar medium. The results already at hand indicate that the plane of polarization approximates to the plane of the galaxy.

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Dec. 27.

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Possibility of a Phase Transition in the Pure Helium Isotope of Mass 3

Sydoriak, Crilly and Hammel[1] have reported the preparation and separation of the pure helium isotope of mass 3. They have succeeded in condensing it and have determined its vapour pressure in the temperature range 1·21°–3·34° K. (the critical temperature) and its boiling point at 3·20° K. These vapour pressure measurements appear to have interesting consequences with regard to the possibility of a phase transition in the pure helium isotope of mass 3. They provide evidence for such a transition at 1·9° K. In this communication, the possibility of this transition is first examined, the vapour pressure equations in the two ranges 1·2–

1·9° K. and 1·9–3·20° K. are given, and a few remarks are made about the theoretical implications of the existence of a phase transition in the pure helium isotope of mass 3.

For a substance the vapour of which behaves as a perfect gas, the vapour pressure equation has the form

$$\log p = 2{\cdot}5 \log T + a/T + i, \qquad (1)$$

where i is the chemical constant. In fitting a curve of this sort to vapour pressure data for helium-4, it has been found[2] that the constants have nearly the theoretical values. This gives some confidence in using a formula of this theoretical form, and it seemed to be worth while to do so for the vapour pressure data for the pure helium isotope of mass 3. The simplest way to do this is to plot the values of

$$\log p - 2{\cdot}5 \log T \qquad (2)$$

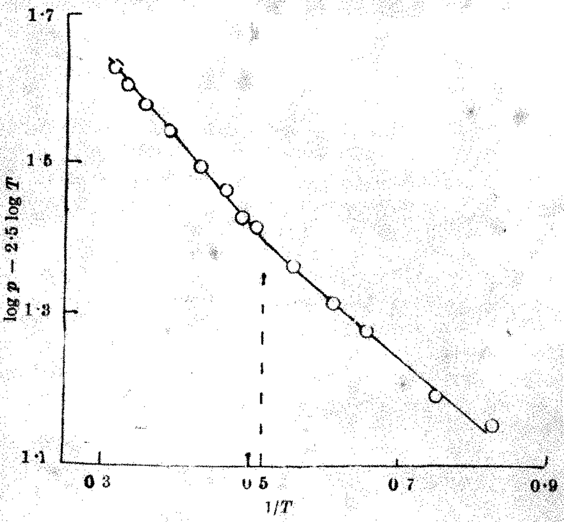
as a function of $1/T$. When this was done for the data on helium-3, it was immediately apparent that all the data did not lie on a single straight line. The experimental points below about 1·9° K. were found to lie on one straight line, while those above 1·9° K. were found to lie on a different straight line, as shown in the accompanying diagram. Non-ideality of the vapour would give a curve convex to the axes, and if there is a wide scatter of the experimental points this may be the explanation. The reported values do adhere so closely to straight lines that it seems improbable that the experimental scatter has fortuitously caused this. The vapour pressure equations for pure helium-3 in the temperature ranges indicated were found to be

$$\log p = 2{\cdot}5 \log T - \frac{0{\cdot}79}{T} + 1{\cdot}795 \qquad (3)$$
$$(1{\cdot}21 < T < 1{\cdot}9^\circ \text{ K.}).$$

$$\log p = 2{\cdot}5 \log T - \frac{1{\cdot}10}{T} + 1{\cdot}960 \qquad (4)$$
$$(1{\cdot}9 < T < 3{\cdot}20^\circ \text{ K.}).$$

In the accompanying table the values of p calculated from equations (3) and (4) are tabulated against the corresponding experimental values. Comparison of the values given in the second and third columns of the table indicates the faithfulness with which equations (3) and (4) represent the experimental data.

The occurrence of the kink shown in the diagram of the plot of expression (2) against $1/T$ is consistent with what would be observed if pure helium-3 underwent a phase transition of the second or higher order at this temperature. The vapour pressure data which have been reported[1] suggest that pure helium-3 exhibits a phase transition at about 1·9° K. This conclusion must, however, be regarded as somewhat speculative until measurements of the physical properties (for example, specific heat, density) have been made. In particular, it would be worth while to look for discontinuities in their temperature variation in the neighbourhood of 1·9° K.



Temperature (° K.)	Pressure (mm. mercury) Calculated	Observed
1·211	22·5	23
1·334	33	32
1·524	54	54
1·635	70	70
1·795	98	99
1·977	139	141
2·047	158	159
2·152	190	195
2·327	253	255
2·580	364	366
2·817	493	495
3·032	630	634
3·201	756	764

The conclusion that the vapour pressure data indicates a lambda-transition in pure helium-3 is put forward with all due caution. In this connexion it must be remembered that the lambda-transition in the isotope of mass 4 was not deduced from any discontinuity in the temperature derivatives of the vapour pressure. For helium-4, such a discontinuity was, in fact, detected only after the phase transition at 2·19° K. had been discovered by other means. The discontinuity shown in the gradient of the vapour pressure measurements on helium-3 is greater than that shown by the vapour pressure of helium-4 at its lambda point.

It has generally been assumed that the lambda-transition in helium-4 is a manifestation of Bose–Einstein condensation. In this connexion it should be noted, however, that the Bose–Einstein condensation gives the wrong kind of transition[4], that it has never been demonstrated to exist for interacting particles and that 'demonstrations' of its existence for non-interacting particles are far from rigorous[5]. If helium-3 also shows a second-order phase transition, this would provide *prima facie* evidence that the *existence* of such a phase transition could not be a consequence of the particular quantal statistics obeyed by the assembly of particles. It would thus rule out any attempt at a theory of the phase transition in helium-4 which depends on the fact that helium-4 atoms obey Bose–Einstein statistics. It would be tempting to suggest that if helium-3 has a phase transition in the neighbourhood of 1·9° K., then below this temperature it will exhibit 'superfluid' properties analogous to those shown by helium-4 below 2·19° K., but no such conclusion can be deduced from the existing data. Although it is probable that below such a transition temperature helium-3 would have unusual properties, their precise nature could be determined only by experiments explicitly designed to examine this. The point is that, although a phase transition of the second order in helium-3 would indicate that the *existence* of such transitions is independent of the statistics obeyed by the assembly of particles, the particular properties shown by the assembly below the transition temperature may well depend on these statistics.

Note added in proof. In discussion of these results with Prof. Simon, he has pointed out that the slopes of the two lines indicate that if the effect is genuine it corresponds to a *defect* of specific heat.

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Cambridge. Dec. 15.

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Crystal Structure of Strontium Laurate

STRONTIUM soaps of even-n fatty acids from caproic to stearic were examined by X-rays; they exhibit several crystallographic forms. Form A is obtained by precipitation from an aqueous solution of a sodium soap; the long spacings follow a law, $d = 5{\cdot}879 + 2{\cdot}475\,N$, where N is the number of carbon atoms in the corresponding fatty acid. Form B follows a law, $d = 3{\cdot}95 + 2{\cdot}447\,N$; it can generally be obtained by heating A. The forms show a certain amount of variability of their powder patterns, the causes of which are not yet known. The increment of their long spacings indicates that in both forms the hydrocarbon-chain axes are perpendicular or nearly perpendicular to the ionic sheet planes; they differ in the structure of the ionic sheet or arrangement of the CH_3 end-groups rather than in their angle of tilt. Strontium caproate and one sample of myristate gave patterns indicating the existence of further forms.

Single crystals of the form A of strontium laurate were grown from alcoholic solution. They are long thin plates; a twinned crystal was also found. Rotation photographs, zero and higher layer Weissenberg photographs were taken about the a and c axes using nickel-filtered copper $K\alpha$ radiation. The crystals are monoclinic and the cell dimensions are: $a = 7{\cdot}803$ kX., $b = 70{\cdot}86$ kX., $c = 4{\cdot}75$ kX., $\beta = 102° \, 36'$; density (meas.) 1·27 gm./c.c., (calc.) 1·25 gm./c.c. (assuming four molecules $Sr(C_{12}H_{23}O_2)_2$ per unit cell).

There are many absent reflexions, including $(0k0)$ absent when k is odd and $(h0l)$ absent when $h + l$ is odd. The space group is thus probably $C^5_{2h} - P2_1/n$. Further absences can be explained by assuming that for each atom at x, y, z, there is another atom at $\pm x \pm \frac{1}{4}, y + \frac{1}{2}, z$. This limits the position of the strontium atom to certain special positions. The chains are oriented along the b-axis, which roughly corresponds to the length of four fatty-acid chains.

The intensities of the reflexions were estimated by eye. The y co-ordinates of the atoms were approximately determined by a modified Booth method of steepest descents. The calculations were made on our mechanical structure-factor calculating machine. Probable signs of the $(0kl)$ reflexions were then obtained from the position of the strontium atom, and a Fourier projection on the bc face was prepared by trial and error. The average distance between two alternate carbon atoms in the undistorted part of the chain is 2·605 kX. This compares well with the distance 2·593 kX. found by us in potassium caprate.

We are indebted to Mr. T. R. Lomer for valuable help.

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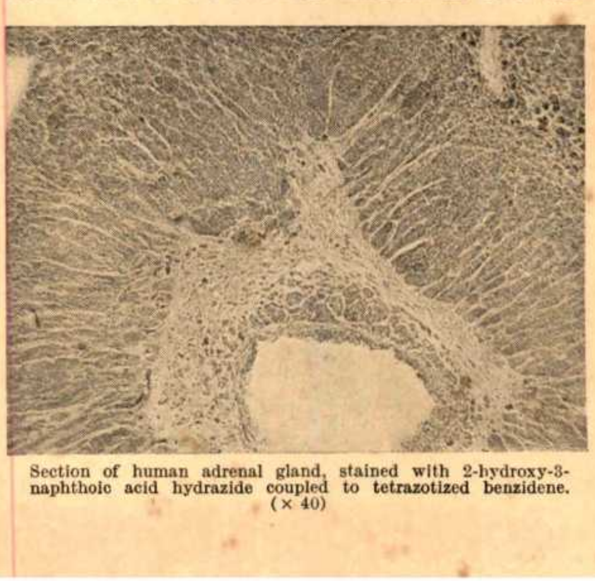
Histochemical Demonstration of Ketosteroids in the Adrenal Cortex

VARIOUS attempts have been made to develop a histochemical method for demonstrating the presence of ketosteroids within the cells of the adrenal cortex[1-7]. These have depended on the formation of coloured hydrazones of the ketosteroids. The low staining intensity of the hydrazones and the minute quantities of the ketosteroids present in the cells have rendered it difficult to locate with accuracy the chromogenic material except in relatively thick sections. Coloured compounds of much greater intensity can be produced if the aryl-hydrazones of the ketosteroids are coupled with diazonium salts. Any degree of solubility can be conferred on the final coupled compound by selecting the most suitable diazonium salt. This permits of the staining of blocks of fixed tissues, the use of paraffin embedding, counterstaining of the sections and clearing and mounting by the usual techniques.

An example of the use of this method is as follows. Formalin-fixed tissue, thoroughly washed in running water, is sectioned on the freezing microtome. The sections (5 μ) are allowed to remain overnight in a saturated aqueous solution of 2-hydroxy-3-naphthoic acid hydrazide[8] and washed in $N/100$ hydrochloric acid and then in distilled water to remove excess reagent, immersed in a solution of 0·4 per cent sodium hydroxide and transferred to a dilute solution of the diazonium salt. This may be prepared from a stabilized diazonium salt, or the following method may be used: 1 m. equiv. of the primary aromatic amine is dissolved in 2·5 ml. N hydrochloric acid (2·5 m. equiv.), and 70 mgm. sodium nitrite (1 m. equiv.) dissolved in 1 ml. distilled water is added to bring about diazotization. Excess nitrous acid would lead to rupture of the hydrazone linkage[9] and is disposed of by the use of sulphamic acid. Approximately 0·5 ml. of the diazonium salt solution added to 250 ml. of distilled water provides a suitable concentration for coupling. If the diazonium salt solution is too strong, staining tends to be patchy. The sections may then be counterstained, cleared and mounted in the usual way. The intensity of the reaction is improved if, before coupling, the sections are put into distilled water to which tincture of iodine is added until a faint straw colour is obtained. After five minutes, 1 per cent sodium thiosulphate solution is added, drop by drop, until the solution is cleared. The distribution of the coloured material in otherwise



Section of human adrenal gland, stained with 2-hydroxy-3-naphthoic acid hydrazide coupled to tetrazotized benzidene. (× 40) unstained adrenal tissue is illustrated in the accompanying figure. The specificity of this colour reaction for ketosteroids is being investigated.

The principle of coupling the hydrazones of ketosteroids with diazonium salts to form coloured azo-derivatives has been found to be applicable also to the investigation of the ketosteroids of body fluids. Estimation of the ketosteroids may be carried out either by fluorimetry of the hydrazones or by colorimetry of the azo-derivatives. Chromatographic separation of mixtures of ketosteroids is possible by using a diazonium salt with the necessary solubilizing properties. The intense colour of the azo-derivatives renders their recognition easy, even when present only in small amounts. Alternatively, chromatographic separation of the hydrazones of the ketosteroids can be effected. The migration of these compounds can be followed by making use of their fluorescence under ultra-violet light. Work along these lines is proceeding.

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Reversible Action of D.D.T.

Some unusual relationships between temperature, cuticle permeability, and metabolic activity have emerged from a study of the action of D.D.T. on resistant insects. Observations that the primary stages of D.D.T. poisoning are reversible have provided a clue to the mode of action of this substance and related compounds, which is analogous to that of liquid fat-solvent narcotics. The supporting evidence may be briefly summarized as follows.

Mature *Calliphora erythrocephala* blowfly larvæ were extremely resistant to the contact action of excess crystalline D.D.T., and they pupated and metamorphosed normally within two to three days (20° C.). Paralysis followed exposure to a higher temperature (36° C.) for two hours, but only after the temperature was lowered (20° C.). The larvæ recovered when the temperature was raised. The experiment shows that the permeability of the cuticle to D.D.T. is increased at high temperatures, and since the uptake of crystalline D.D.T. involves a solubilization in the cuticle lipids, the change is consistent with an increase in the mobility of the lipid molecules in the outer epicuticle[1].

The response shown to change in temperature was reversible many times, suggesting that paralysis represents an equilibrium condition in which the D.D.T. present in the cuticle lipids acts selectively on the peripheral nervous system, for there was no interference with pupation, or with metamorphosis. The equilibrium condition may be varied experimentally by: (*a*) detoxication of D.D.T. at the site of action, (*b*) increase in the storage capacity of the cuticle lipids by fat-solvent action, and (*c*) decrease in the storage capacity of the lipids by adsorption displacement of the more mobile components on to 'inert' adsorbent powders. Factors (*a*) and (*c*) antagonize D.D.T. activity; (*b*) increases D.D.T. activity.

(*a*) When the cuticles were painted with a solution (5 per cent) of caustic potash, the paralysed larvæ recovered almost immediately. Presumably the D.D.T. inside the cuticle was hydrolysed *in situ* to the inactive derivative, αα-*bis*-(*p*-chlorophenyl)-ββ-dichloroethylene[2]. This detoxication response indicates that interference with metabolism is primarily reversible.

(*b*) When immersed in a solution (2 per cent) of D.D.T. in kerosene, *Calliphora* larvæ were paralysed within twenty to thirty minutes (20° C.). They did not recover when the temperature was raised. Under these conditions, the kerosene alone is inactive, but it greatly increases cuticle permeability, so that a higher concentration of D.D.T. accumulates at the peripheral nervous system[3].

(*c*) Adult *Calliphora* flies were paralysed rapidly (15–20 min.; 20° C.) by contact with excess crystalline D.D.T.; but if they were first sprinkled lightly with fine alumina powder, the time for the onset of paralysis increased two to four times; chalk and talc, which do not adsorb the cuticle lipids, increased paralysis time slightly by a physical diluent action on the D.D.T., which was overshadowed by the adsorption effect with alumina[1]. Partial recovery from paralysis occurred when the temperature was raised, and the effect was reversible.

These results may be interpreted in terms of the dynamic balance between a rate of D.D.T. activity and a rate of metabolism, both being dependent on temperature. With the resistant larva, the temperature coefficient of D.D.T. activity is smaller than that of metabolic activity, so that the critical metabolic level essential for nervous co-ordination is attained at high, but not at low, temperatures. The reverse relationship holds for kerosene-sensitized larvæ and flies, where D.D.T. activity remains a limiting factor with temperature change; the insects do not respond to a rise in temperature, or to treatment with alkali. Alumina treatment decreases the coefficient of D.D.T. activity, so that the temperature response is shown.

A guide to the nature of the interference in oxidative metabolism was obtained from the observations that the symptoms of D.D.T. paralysis are very similar to the unco-ordinated 'tremors' shown by insects recovering from the narcotic effects of ether, chloroform, or amyl alcohol. It is generally agreed that fat-solvent narcotics exert a relatively non-specific action on intracellular respiratory systems by inhibiting the dehydrogenase systems, such as succinic dehydrogenase, which reduce cytochrome, and these reducing systems show a high temperature coefficient of activity[4]. The average rate of uptake of oxygen by mature *Calliphora* larvæ at 20° C. (measured by a metal micro-respirometer of the type described by Crisp and Thorpe[5]) was found to be 23·6 c.mm./gm./min.; after paralysis by contact with crystalline D.D.T. at 36° C. for two hours, it fell to 7·8 c.mm./gm./min. Changes in respiration-rate and the degrees of recovery from paralysis were compared after injection of sodium succinate, pyruvate, lactate and glucose into the blood of larvæ from the same batch of paralysed insects (dosage per insect, 0·15 c.c. 1 per cent solution in phosphate buffer, *p*H 7·4). Succinate induced complete, and glucose partial, recovery; lactate and pyruvate were ineffective. The uptakes of oxygen after injection were: succinate, 17·8; glucose, 11·2; pyruvate, 7·2; and lactate, 6·9 c.mm./gm./min.

Narcosis produced by injection of 0·4 per cent chloroform, 1·0 per cent ether, or 0·6 per cent amyl alcohol (0·15 c.c. aqueous solution) into the blood of mature larvæ was also antagonized by simultaneous injection of 1 per cent succinate; but not by glucose, lactate, or pyruvate. After succinate injection, adult blowflies became considerably more resistant to the narcotic action of these fat solvents applied internally by injection, or externally in vapour form. Flies treated externally with alumina and internally with succinate remained active in the presence of crystalline D.D.T. for several hours, showing clearly the combined influence of permeability and metabolic factors on D.D.T. activity.

These results show that the cuticle lipids play an important part in influencing the selective action of D.D.T. at the peripheral nervous system; but the action is primarily reversible and analogous to the narcotic actions of fat solvents, involving an interference with the utilization of succinate, an essential metabolite in oxidative metabolism. Succinate antagonism has also been observed with analogues of D.D.T., and with the structurally unrelated 'Gammexane' (γ-hexachloro*cyclo*hexane).

A full account of this work will appear elsewhere.

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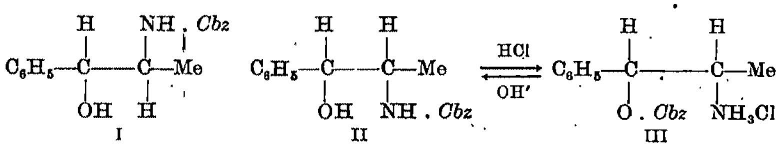
Separation of Diastereoisomeric Amino-Alcohols

The separation of diastereoisomeric amino-alcohols is of importance as they have very different pharmacological properties. Hitherto fractional crystallization has been used as the only suitable method for this purpose; however, sometimes, for example, in separating *nor*-ephedrine from *nor*-ψ-ephedrine[1], it proved to be unsatisfactory.

We have devised a new method of separation based on the different behaviour of diastereoisomeric N-acyl-amino alcohols towards alcoholic hydrogen chloride[2,3]. When a mixture of N-benzoyl-*dl-nor*-ephedrine and of N-benzoyl-*dl-nor*-ψ-ephedrine was treated with nearly the equimolar amount of this reactant, the former amide could be recovered unchanged, whereas the latter was quantitatively converted—due to an acyl shift N → O—into O-benzoyl-*dl-nor*-ψ-ephedrine hydrochloride. This water-soluble salt was easily separated from the insoluble amide in good yield. The same method also proved useful in separating amino-alcohols of other type; for example, N-benzoyl ephedrine and N-acetyl-1.2-diphenyl-amino-ethanol from their stereoisomers.



$$C_6H_5-\underset{OH}{\overset{H}{C}}-\underset{H}{\overset{NH\cdot Cbz}{C}}-Me \qquad C_6H_5-\underset{OH}{\overset{H}{C}}-\underset{NH\cdot Cbz}{\overset{H}{C}}-Me \underset{OH'}{\overset{HCl}{\rightleftharpoons}} C_6H_5-\underset{O\cdot Cbz}{\overset{H}{C}}-\underset{NH_3Cl}{\overset{H}{C}}-Me$$

I II III

$Cbz = C_6H_5\cdot CH_2OOC$—

However, the conversion of the separated acyl derivatives into the appropriate amino-alcohols by acid hydrolysis may sometimes effect Walden inversion[4]; on the other hand, alkaline deacylation could result in a cleavage to aldehydes[5]. To avoid this difficulty, we attempted the separation of N-carbobenzoxy derivatives of diastereoisomeric amino-alcohols with subsequent removal of the protecting group by hydrogenolysis, that is, under very mild conditions. We succeeded in separating N-carbobenzoxy-*dl-nor*-ephedrine (I, m.p. 103°) from N-carbobenzoxy-*dl-nor*-ψ-ephedrine (II, m.p. 83°) on converting the latter by acyl migration N → O into the water-soluble hydrochloride of O-carbobenzoxy-*dl-nor*-ψ-ephedrine (III, m.p. 229°); this furnished on alkalinization (owing to a reverse acyl migration O → N) the N-carbobenzoxy derivative (II, m.p. 83°). As expected, hydrogenolysis afforded from the separated carbobenzoxy derivative I the amino-alcohol *nor-dl*-ephedrine, from II *dl-nor*-ψ-ephedrine, with very good yields. This new method will be investigated with further types of amino-alcohols, and details will be published later.

This separation was made possible by the fact that in the molecule of the type of pseudo-ephedrine, more suitable steric conditions are available for acyl migration than in that of ephedrine. Obviously, the hypothesis of free rotation around the simple C—C linkage in this series of compounds[6] appears to be invalid[7].

This theoretical problem will be treated in detail elsewhere[8].

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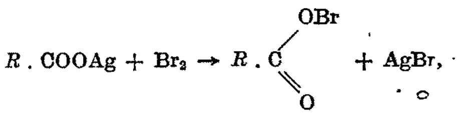
Reaction of Bromine with Silver (+)-α-Phenylpropionate: an Electrophilic Bimolecular Substitution

In a review of the literature of the reactions of the silver salts of carboxylic acids with bromine, Kleinberg[1] has concluded that when one equivalent of salt reacts with two of bromine, an intermediate compound *R*.COOBr is formed,



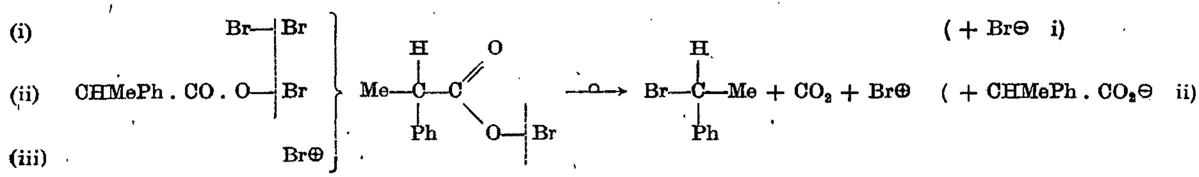
$$R\cdot COOAg + Br_2 \rightarrow R\cdot C\overset{OBr}{\underset{O}{\lessgtr}} + AgBr,$$

which decarboxylates to give the bromide *R*Br, and from the addition of *R*.COOBr to olefins and other reactions, that the bromine atom reacts as a 'positive' halogen.

In order to elucidate further the mechanism of the substitution of carboxyl by bromine, silver α-phenylpropionate, prepared from the acid having $\alpha_D^{15^\circ} + 42{\cdot}3^\circ$ (1, 0·5), optical purity 81·7 per cent, was allowed to react in boiling carbon tetrachloride with two equivalents of bromine; it gave, in good yield, α-phenylethyl bromide, $\alpha_D^{16^\circ} + 46{\cdot}2^\circ$ (1, 1·0), optical purity 35·2 per cent by comparison with the highest recorded rotation for this compound, $\alpha_D^{18^\circ}$ 131·4° (1, 1·0)[2].

The retention of asymmetry for this substitution is thus 43·1 per cent, and the following data permit comparison of the configurations of the acid and the bromide. (+)-α-Phenylpropionic acid has been converted with retention of configuration to (−)-α-phenylethylamine by the Hofmann and other rearrangements[3]. The (−)-amine with nitrous acid yields (+)-α-phenylethyl alcohol with considerable racemization[4]: it is considered that during this reaction the diazonium ion CHMePh.$N_2^{\oplus}$ dissociates into nitrogen and the ion CHMePh⊕, and that the latter reacts with water to form the alcohol with a preponderance of the inverted configuration, due to shielding of the original point of attachment by the released nitrogen molecule. Finally, (+)-α-phenylethyl alcohol and (+)-α-phenylethyl bromide have the same configuration[5]. Thus (+)-α-phenylpropionic acid and (+)-α-phenylethyl bromide have opposite configurations, and the silver salt – bromine reaction proceeds with inversion of configuration.

The following mechanism for the reaction is put forward: the molecule CHMePh.COOBr is first formed and then, by reaction with bromine (i), or with a second similar molecule (ii), the ion Br⊕ is formed in small concentration; thereafter reaction proceeds by (iii), a chain-reaction regenerating Br⊕:



The α-phenylethyl bromide formed by this mechanism would be fully inverted; the bromide obtained experimentally was inverted but partially racemized.

α-Phenylethyl bromide, $\alpha_D^{17^\circ}$ 96·6° (1, 1·0), was dissolved in carbon tetrachloride and heated under reflux for one hour with silver bromide and a small quantity of bromine; the α-phenylethyl bromide recovered from this solution had $\alpha_D^{18^\circ}$ 0·2° (1, 1·0). Racemization may have occurred either by bimolecular halogen exchange or by a radical reaction:

$$R\text{Br} + \text{Br}_2 \rightarrow R\cdot + \text{Br}_2 + \text{Br}\cdot \quad ; \quad R\cdot + \text{Br}\cdot \rightarrow R\text{Br}.$$

From this observation it is concluded that the bromide of the original experiment was racemized after its formation.

The silver salt – bromine reaction is a bimolecular substitution with inversion of configuration effected by electrophilic reagents, 'positive' bromine and bromine anion, and appears to be the first established example of this class of replacement reaction.

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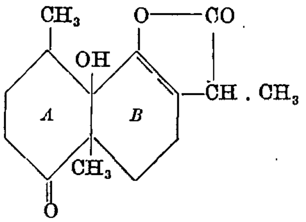
Desmotropo-ψ-Santonins

The butanolide structure proposed by Clemo and Cocker[1] for desmotropo-ψ-santonin (II) [p. 289], which is formed by the action of warm 55 per cent sulphuric acid on ψ-santonin, has been confirmed (compare Cocker and Lipman[2]). An intermediate compound in this transformation is now named ψ-santonic acid, to which structure (III) is tentatively assigned. Assuming that the most likely structure for ψ-santonin is (I), the conversion of this to (II) involves the destruction of asymmetry at C_1, C_5 and C_{10}. In addition, C_8 and C_9 will also be affected during the reduction of ring *B*, which probably takes place by bond migration. By the nature of the acidic reagent involved in the re-arrangement, it is most unlikely that the configuration of C_{11} will be affected. Hence the conversion of ψ-santonin to desmotropo-ψ-santonin should lead to two pairs of diastereoisomers in both of which the configuration of C_{11} should be the same. Two of the latter should have the *cis* configuration and the other two the *trans* configuration at C_8—C_9.

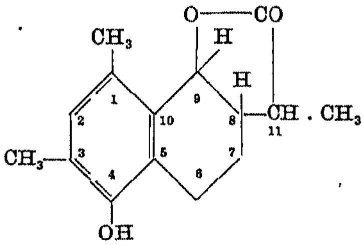
The conversion of ψ-santonin to desmotropo-ψ-santonin is now found to yield a mixture of desmotropo compounds. Crystallization of this mixture yields the desmotropo compound (m.p. 189°; $[\alpha]_D^{20^\circ} + 68^\circ$) already described, which we now name + β-desmotropo-ψ-santonin, in accordance with the nomenclature of Huang Minlon *et al.*[3], and a second desmotropo compound + α-*iso*-desmotropo-ψ-santonin, m.p. 251–253°; $[\alpha]_D^{20^\circ} + 68{\cdot}5^\circ$.

When + β-desmotropo-ψ-santonin is heated in boiling anhydrous xylene with anhydrous potassium carbonate, it gives + α-desmotropo-ψ-santonin (m.p. 171–172°; $[\alpha]_D^{20^\circ} + 153^\circ$). The new compound is probably produced by the inversion of C_{11} through the enol, and it is unlikely that C_8 and C_9 are affected. The lactone ring is, in fact, not opened.

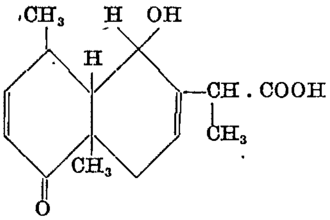
When + α-*iso*-desmotropo-ψ-santonin is treated in a similar manner or heated above its melting point, a fourth dextrorotatory desmotropo compound, + β-*iso*-desmotropo-ψ-santonin (m.p. 268–270°; $[\alpha]_D^{20^\circ} + 165^\circ$) is obtained.



(I)



(II)



(III)

We have thus obtained the four possible dextro forms. So far, attempts to invert C_8 and C_9 by acidic reagents have either yielded unchanged compounds or intractable mixtures; but further work on this point is in progress.

The work described forms part of a much wider investigation on the structure of ψ-santonin, the results of which will shortly be submitted for publication elsewhere.

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---

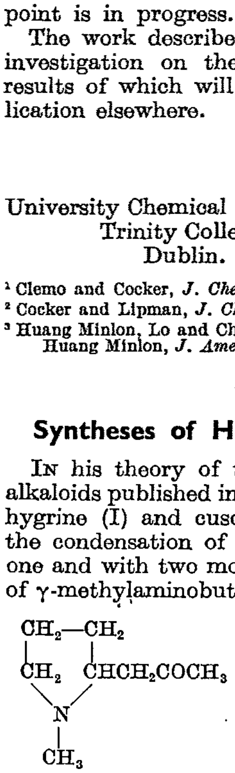
[1] Clemo and Cocker, *J. Chem. Soc.*, 30 (1946).

[2] Cocker and Lipman, *J. Chem. Soc.*, 533 (1947).

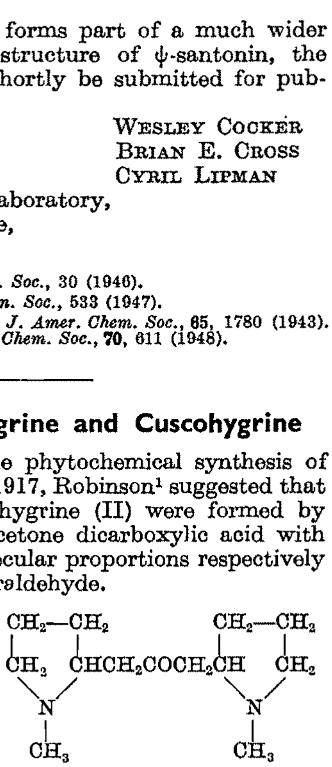
[3] Huang Minlon, Lo and Chu, *J. Amer. Chem. Soc.*, **65**, 1780 (1943). Huang Minlon, *J. Amer. Chem. Soc.*, **70**, 611 (1948).

Syntheses of Hygrine and Cuscohygrine

In his theory of the phytochemical synthesis of alkaloids published in 1917, Robinson[1] suggested that hygrine (I) and cuscohygrine (II) were formed by the condensation of acetone dicarboxylic acid with one and with two molecular proportions respectively of γ-methylaminobutyraldehyde.



(I)



(II)

Robinson's theory became widely known and is frequently stated in text-books; but no attempt to carry out these reactions seems to have been made for nearly twenty years. Then in 1936 he[2] announced that "a synthesis of *dl*-hygrine on these lines has proved feasible", but so far as we are aware no account of this synthesis has appeared. Later, Schöpf[3] reported that he was unable to obtain *nor*hygrine from γ-aminobutyraldehyde and acetoacetic acid, although the phenyl analogue of this base was formed from the same aldehyde and benzoylacetic acid.

We have now found that acetone dicarboxylic acid condenses smoothly with two molecular proportions of γ-methylaminobutyraldehyde at *p*H 7 to produce cuscohygrine in excellent yield. The identification of the product was made by direct comparison of several of its derivatives with authentic specimens and by the agreement of the analytical figures with the calculated values. Similarly, we have obtained from the reaction between excess acetoacetic acid and γ-methylaminobutyraldehyde a base which we believe to be *dl*-hygrine. The physical constants of the base and its derivatives agree with the values recorded in the literature, and the analytical figures also accord with the calculated values. Although we have not yet had the opportunity of making direct comparisons with authentic specimens, there can be little doubt that the synthetic product is *dl*-hygrine.

Full details of this work, including a discussion of the stereochemistry of cuscohygrine, will be published shortly.

We are greatly indebted to Prof. R. L. Shriner of the State University of Iowa for the provision of a sample of authentic cuscohygrine.

E. Anet
G. K. Hughes
E. Ritchie

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Applied Chemistry,
University of Sydney.
July 16.

---

[1] Robinson, R., *J. Chem. Soc.*, 876 (1917).

[2] Robinson, R., *J. Chem. Soc.*, 1079 (1936).

[3] Schöpf, C., *Z. Angew. Chem.*, **50**, 797 (1937).

I would like to congratulate the authors on these syntheses, which are fundamental for the theory. My own synthesis, mentioned in 1936, employed acetonedicarboxylic acid in excess, but was otherwise identical. Though the product was undoubtedly *dl*-hygrine, the opportunity to add the final touches necessary for publication did not occur.

It is very satisfactory that this synthesis will now be placed on record and will become available for reference.

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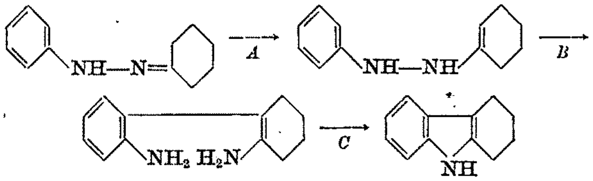
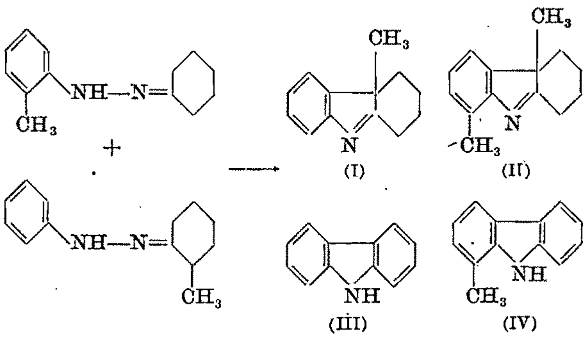
Dec. 2.

Mechanism of the Fischer Indole Synthesis

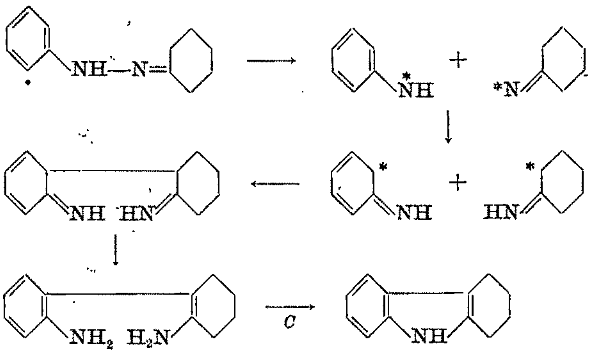
The mechanism previously proposed[1,2] for the Fischer indole reaction has assumed that the intermediate stages involve an *o*-benzidine-type re-arrangement. This may be illustrated as follows, considering, as an example, the phenyl hydrazone of *cyclo*hexanone:



Ingold[3] has clearly shown that the benzidine rearrangement is intramolecular in nature, but it has now been found that the Fischer indole synthesis proceeds by an intermolecular reaction. This fact was proved by studying the cyclization of a mixture of equal weights of the *o*-tolyl hydrazone of *cyclo*hexanone and the phenyl hydrazone of 2-methyl *cyclo*hexanone in boiling glacial acetic acid solution. The basic products formed in this reaction were 11-methyl- (I) and 8 : 11-dimethyltetrahydrocarbazolenine (II), and the neutral products gave, after dehydrogenation, carbazole (III) and 1-methyl carbazole (IV). These four products were formed in practically equivalent proportions.



Thus it is apparent that fission of the N—N linkage has taken place and that an intermolecular reaction is involved. The full implications of these results, and the importance of certain by-products from *o*-halo-substituted phenylhydrazones of *cyclo*hexanone[4], will be discussed in detail elsewhere. The provisional mechanism proposed may be formulated as shown :



Alternatively, stage *A* (see above) may occur initially, but, in either case, the same intermediate is formed as that resulting from stage *B* (an *o*-benzidine re-arrangement).

The validity of this free radical mechanism, as opposed to an ionic mechanism, is being tested by kinetic evidence.

K. H. PAUSACKER
C. I. SCHUBERT

Johnson Chemical Laboratories,
University of Adelaide.
Sept. 10.

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[1] Robinson and Robinson, *J. Chem. Soc.*, 113, 639 (1918); 125, 827 (1924).

[2] Allen and Wilson, *J. Amer. Chem. Soc.*, 65, 611 (1943).

[3] Ingold and Kidd, *J. Chem. Soc.*, 984 (1933).

[4] Pausacker and Robinson, *J. Chem. Soc.*, 1557 (1947).

Polarography with Slowly Forming Mercury Drops

BY means of a capillary greatly restricted in the stem but with an orifice radius of 108 μ, it has been found possible to study current – time and current – voltage curves for single mercury drops with ordinary polarographic equipment—a Cambridge polarograph with photographic recording. Drop-times in a given solution could be varied between 16 sec. and 8 min. and were reproducible. The drop-weight in $0 \cdot 1\,N$ potassium chloride was about 28 mgm. The results show the change in character of current – time curves at constant voltage as the voltage is altered, give accurately measurable values for current – time relations during cathodic reduction, and indicate a new use for the polarograph in quantitative analysis by reason of the appearance of non-suppressible maxima on current – voltage curves.

The current – time curves of growing drops with no reducible matter present show that the current gradually rises when the applied potential is positive to that of the electrocapillary maximum, but that it gradually decreases when the potential is more negative, the falling-off of a drop being accompanied by a sudden downward jump of current in the first case and a sudden upward jump in the second. With sodium sulphite and zinc sulphate in oxygen-free potassium chloride solution, current – time curves at successively increasing negative potentials (*vs.* saturated calomel electrode) show that inversions of shape occur between $-0 \cdot 1$ and $-0 \cdot 2$ V., $-0 \cdot 4$ and $-0 \cdot 6$ V. (at the electrocapillary maximum), and $-0 \cdot 9$ and $-1 \cdot 1$ V. (deposition of zinc); for example, the current decreases with drop growth at $-0 \cdot 1$ and $-0 \cdot 7$ V., and increases with drop-growth at $-0 \cdot 3$ V. and $-1 \cdot 2$ V. The occurrence of such effects, which are also observable with normal capillaries (drop times 2–7 sec.), should have, *inter alia*, some bearing on the method of measuring wave-heights, but a study of numerous papers has failed to reveal that workers realize their existence.

Current – time curves for reductions at constant applied potential approximate closely to ordinary parabolas, $i \propto t^{1/2}$. This fact conflicts with conclusions derived from the Ilkovic equation ($i \propto t^{1/6}$), but it accords qualitatively with Steghart's findings[1] in the case of a rapid-dropping capillary studied by means of a high-speed, high-precision recorder.

Current – voltage curves during the life-time of a single drop over the range corresponding to a reduction show a current-peak in place of the initial part of the usual flat diffusion-current portion of the polarographic curve. The peak is not a polarographic 'maximum' since it is not removable by a maximum suppressor and the peak currents do not appear with drops taken at constant potential. With a given solution, the peak-height increases with the size attained by the drop at the potential of the peak, and is linearly related to the volume and not the surface area of the drop. The maximal values of the peaks obtained at various drop-rates are identical. The peak potential is independent of the size of the drop at the peak when the rate of flow of mercury is kept constant, but it becomes more negative as the rate of flow is increased.

If the potential rise is started at the same size of drop-growth in solutions containing various amounts of reducible matter, the peak height is proportional to the concentration. The records obtained, for example, with Cd•• and Zn••, are smooth steep curves rising to well-defined peaks, the heights of which can be measured with much greater certainty than ordinary step-heights.

With special equipment for very rapid application of potential and oscillographic recording, Matheson and Nichols[2] and, later, Randles[3], found peaks on current – voltage curves obtained with normal capillaries. The present results are given by the usual slow rate of application of potential, and no special equipment other than the capillary is required. The investigation is being continued and details will be given elsewhere.

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Sept. 18.

[1] Steghart, F. L., in contribution to a discussion, *Analyst*, **72**, 234 (1947).

[2] Matheson, L. A., and Nichols, N., *Trans. Electrochem. Soc.*, **73**, 193 (1938).

[3] Randles, J. E. B., *Trans. Farad. Soc.*, **44**, 322 (1948).

Mercury Photosensitized Reaction of Tetrafluoroethylene

I have found that the irradiation of tetrafluoroethylene in the presence of mercury vapour by light of wave-length 2536 A. causes a mercury photosensitized reaction. The pressure falls and a white powder is formed. A gas of molecular weight 150 ± 1, b.p. – 33° C., m.p. – 80° C., believed to be hexafluoro*cyclo*propane, molecular weight 150, b.p. – 31° C.[1], and a small quantity of a mixture of compounds with higher boiling points have been isolated from the products of the reaction. The white powder has properties similar to those of polytetrafluoroethylene $(CF_2)_n$ [2], the product of the catalysed polymerization of tetrafluoroethylene.

The quantum efficiency of the reaction at various pressures has been measured. At pressures below 10 cm. of mercury, quenching of the mercury fluorescence is not complete, and only very approximate calculations of quantum efficiency can be made. Some of the quantum efficiencies obtained are given in the accompanying table.

Temperature (° C.)	Initial pressure (cm. mercury)	Light absorbed (quanta/hr. × 10^{-18})	$\eta_{C_3F_6}$	φ_P
29·8	10·43	1·33	0·03	0·18
29·8	33·61	1·38	0·32	0·30
29·8	8·01	91	0·017	0·02
29·8	35·03	104	0·07	0·12

$$\eta_{C_3F_6} = \frac{\text{molecules } C_3F_6 \text{ formed}}{2 \times \text{quanta absorbed}}; \quad \varphi_P = \frac{\text{molecules } C_2F_4 \text{ polymerized}}{\text{quanta absorbed}}$$

The quantum efficiency of hexafluoro*cyclo*propane production increases with increasing pressure and decreases with increasing intensity. As this compound is the main product, one of the primary reactions must involve the breaking of a carbon–carbon bond. The formation of a polymer indicates the presence of free radicals in the system, and the decrease of efficiency of perfluoro*cyclo*propane production with increasing intensity can be accounted for only by a radical recombination reaction. The results obtained are in accord with the following reaction scheme.

$$\begin{aligned} C_2F_4 + Hg(^3P_1) &= 2CF_2 + Hg(^1S_0); && (1)\\ CF_2 + C_2F_4 &= C_3F_6; && (2)\\ 2CF_2 + C_2F_4 &= 2C_2F_4; && (3)\\ CF_2 + CF_2 &= C_2F_4 \text{ (at the walls).} && (4) \end{aligned}$$

Reaction (2) is probably the reaction initiating polymer formation.

A surprising feature of the reaction is that the 112 k.cal. per gm. mol. available from the excited mercury atoms is sufficient to cause the carbon–carbon bond to break. The bond-energy of the double bond in ethylene is stated to be 153 k.cal. per gm. mol.[3] If the double bond in tetrafluoroethylene has about the same bond-energy, reaction (1) can take place only if the bond-energy of the carbon–fluorine bond in the difluoro-methylene radical is approximately 10 k.cal. higher than the corresponding bond-energy in tetrafluoroethylene. The reaction of tetrafluoroethylene may be contrasted with the mercury-photosensitized reaction of ethylene, in which acetylene and hydrogen are the primary products[4].

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London, S.W.7.
Oct. 1.

[1] Harmon, J., U.S. Patent 2,404,374 (1946).

[2] Renfrew, M. M., and Lewis, E. E., *Indust. Eng. Chem.*, **38**, 870 (1946).

[3] Walsh, A. D., *Trans. Farad. Soc.*, **42**, 779 (1946).

[4] Le Roy, D. J., and Steacie, E. W. R., *J. Chem. Phys.*, **9**, 829 (1941).

An Outline of a Theory of Detonators

Further to the reported property of silver formate of detonating at 85–90° [1], it is perhaps opportune to offer some commentary on the nature of detonators in general. They are commonly derived from acids, the anions of which are the repositories of considerable stores of energy. This is liberated when the anions are discharged and the radicals, thus initially produced, decompose. Anodic discharge from aqueous solution is obviously one method of achieving this, and Audubert has recorded that such discharge of the azide ion is accompanied by liberation of light energy[2]. Another mode of discharge, illustrative of the possible application of these ideas to the picrates, is represented by the action of lead tetracetate on various *para*nitrophenoxide ions, leading to their decomposition into nitric oxide and *para*quinone[3]. In detonators, such anions are associated with heavy metallic cations in what may be approximately described as covalent union[4], and this constitutes a stage in the transition from the fully charged anion to the unstable radical. The process of transition is completed by a suitable supply of energy in the form of a blow, heat or otherwise, and this stage is illustrated by the historic thermal decompositions of mercuric oxide and cyanide and by that of silver salts of carboxylic acids. Local decomposition of this kind in a mass of the detonator will liberate energy, which on communication to immediately adjoining material will cause further decomposition leading to detonation.

Regarding individual detonators, the fulminate ion (CNO)′, derives its energy from the abnormal arrangement of its atoms, as is clear from the fact that oxidation of cyanide ion yields cyanate ion (OCN)′. The fulminate ion, like the azide, formate and picrate ions, is stabilized by resonance; but the double negative charge by itself accounts for the existence of the acetylide ion[5].

J. Kenner

College of Technology,
Manchester.
Oct. 27.

[1] Keller and Kórösy, *Nature*, **162**, 580 (1948).

[2] *Bull. Soc. Chim.*, **7**, No. 5, 907 (1940).

[3] Jones and Kenner, *J. Chem. Soc.*, 1842 (1931).

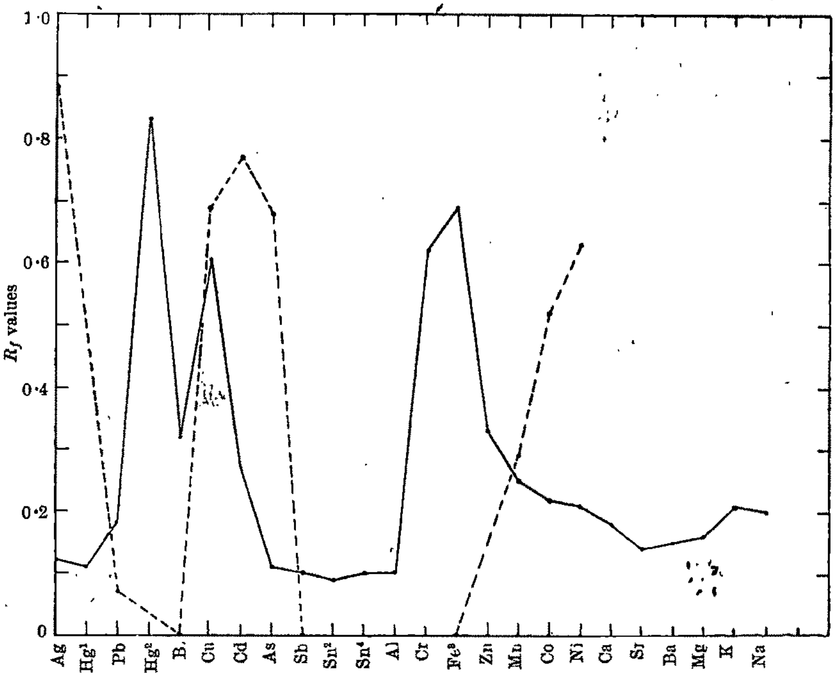
[4] Cf. Pauling, "Nature of the Chemical Bond", 195 (1st edit., 1939).

[5] Cf. Allsop and Kenner, *J. Chem. Soc.*, 2299 (1923).

Inorganic Paper Chromatography and Detection of Cations by Fluorescence

The importance and potentialities of the paper chromatographic separation of inorganic cations have already been indicated by recent communications of Linstead[1] and Lederer[2]. In this laboratory we have been working along similar lines, but with the object of finding general methods of separation and identification, rather than specific methods for two or three ions. Such a scheme has obvious advantages in qualitative analysis.

Our technique is essentially that already described for organic substances by Martin and Synge[3], using Whatman No. 1 filter paper; drops sufficient to give spots of ½ cm. in diameter being placed 4 cm. apart. The solutions were usually approximately $N/10$ in acetic acid. In this way, tests for at least twenty-four cations at a time can be performed and compared with the unknown.



Full line, butanol mixture; broken line, collidine mixture

A variety of solvents has been tried, and the relative R_f values, determined under the conditions of our experiments for two promising solvents, namely: *Solvent* 1, 50 per cent butanol, 10 per cent acetic acid, 5 per cent acetoacetic ester, 35 per cent water; *Solvent* 2, 50 per cent collidine fraction, 50 per cent water, are shown in the accompanying graph. This clearly illustrates the separations possible, and it will be seen that the differential effects of two solvents open up the possibility of two-way separations.

The location of the cations on the paper can be revealed by hydrogen sulphide in some cases; but we have found the use of fluorescence a very marked advantage, since with suitable spraying reagents we can detect nearly all the cations of the ordinary qualitative tables. Our procedure is to spray the dry paper with the selected reagent, allow it to dry and then examine it under the ultra-violet lamp; some of the spots fluoresce and others appear dark through quenching of the fluorescence. From a large number of trials, the following reagents proved most successful: kojic acid, *o*-aminobenzoic acid, morin, 1-naphthylamine-8-sulphonic acid, 2-naphthylamine-1-sulphonic acid. (*Note added in proof.* 8-hydroxyquinoline is extremely useful as a fluorescent reagent.) An interesting effect was noticed, particularly for kojic acid, on subsequent treatment of the paper with ammonia gas; this causes some dark spots to fluoresce (for example, Hg^{++}), quenches the fluorescence of others (for example, Mg^{++}), and makes others quite invisible (for example, As^{+++}). This was used to distinguish between various cations.

The mechanism involved in the separation seems to be essentially partition chromatography for the butanol mixtures, since water alone washes the ions down the paper, while butanol with 10 per cent glacial acetic acid produces almost no movement. Small quantities of acetoacetic ester or glycerol in the butanol mixture tend to concentrate the spots and prevent tailing. For solvents such as collidine, complex formation and adsorption probably have the dominant roles.

F. H. Pollard
J. F. W. McOmie
I. I. M. Elbeih

Department of Chemistry,
University, Bristol.
Dec. 18.

[1] Linstead, *Nature*, **162**, 691 (1948).

[2] Lederer, *Nature*, **162**, 777 (1948).

[3] Martin and Synge, *Biochem. J.*, **35**, 1358 (1941).

Drinking Spouts for Laboratory Animals

Laboratory rats are usually allowed to obtain their water from an inverted glass bulb with a stem, or from an inverted bottle fitted with a bung and spout. The bulbs are awkward to clean and refill, and are very easily broken. The bottles are satisfactory: but the bungs and spouts jam and break, with frequent minor casualties to attendants. The extension of watering to mice, rabbits, guinea pigs, etc., necessitated by the use of diets in the form of dry pellets and cubes (Bruce and Parkes[1,2]), made urgent the elaboration of a more efficient water container.

We have therefore evolved a drinking spout which can be attached to the cap of almost any standard screw-topped bottle. The spout is made from ⅜-in. external diameter 18-gauge metal tubing. The distal end is rounded by spinning to form a vent about ⅛-in. diameter. The proximal end is threaded for about half an inch, and a thin hexagon nut is screwed on up to the end of the thread. The end of the tube is then passed through a ⅜-in. hole pressed in the bottle top and secured by a second nut inside the cap. Both nuts are coated with 'Bostic' to ensure an air-tight joint. A washer inside the cap ensures an air-tight joint with the bottle. Spouts of this type can be made of any appropriate length and shape.

Two types are now in routine use at the National Institute for Medical Research. The first is 6 in. in length with a slight bend, and is attached to the aluminium cap of the standard blood transfusion bottle for use with large cages (for example, rabbit cages), or to the cap of the standard 10-oz. flat bottle for use with smaller cages. The bend in the spout enables it to be used in the horizontal position on top of the cage or in the vertical position on the outside of the cage, to which it is attached by means of a wire holder. Where the cap of the bottle is large, as with the blood transfusion type, it should be strengthened with an 18-gauge disk inside each nut. The second type of spout is short (2 in.) and straight, and is used on the plastic cap of a small squat bottle (ink bottle type) for rat isolation cages or mouse boxes. The spouts can be moved from one type of bottle cap to another as required. The present spouts are made of 'Dural' tubing, and the price is very moderate. The short spout and squat bottle together cost about 25 per cent of the present price of the fragile glass bulb which they replace completely. It is likely, however, that the 'Dural' tubing will prove too soft for use with guinea pigs, and that brass spouts will be required for this species.

We are indebted to Dr. B. Wheeler Robinson for suggestions on design. The equipment described was made by Herbert W. Baker (Engineering), Ltd., St. John's Works, 2a Kilburn Lane, London, W.10.

D. J. SHORT
A. S. PARKES

National Institute for Medical Research,
London, N.W.3.
Oct. 30.

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[1] Bruce, H. M., and Parkes, A. S., *J. Hygiene*, **44**, 501 (1946).

[2] Bruce, H. M., and Parkes, A. S., *J. Hygiene*, **45**, 70 (1947).

Science in the East African Groundnut Scheme

SIR JOHN RUSSELL, stressing, in his address to the le Play Society at Oxford on December 31, the importance of adequate preparatory experimental work before developments such as the groundnut scheme are undertaken, is reported (*The Times*, January 1) as having said that the scientific and technical staff of the scheme "never really had a chance to do their work properly" and that they were "not allowed the necessary time" to make small-scale experiments to discover "the snags and difficulties of the scheme. He is also said to have stated that "those who had been experimenting" in the scheme "were very disappointed with the results".

These reports may give rise to impressions other than those intended by Sir John Russell, and on two points in particular clarification is necessary.

First, it is true that the scheme was started in advance of any detailed experimental work in the areas concerned. This course was dictated by the urgency of the world food position, since it was believed on the technical information and experience available in 1946 that the general conditions were adequate for the economic production of groundnuts and other crops in the areas designated.

This proposition has from the first been under test. I was a member of the advance party which reached Tanganyika early in February 1947, and the scheme's Scientific Department, which now includes seventeen European scientific and technical workers, together with a growing corps of African scientific assistants, has carried out a considerable programme of soil and vegetation surveys, followed by laboratory and field studies of soil fertility, alternate cropping and rotations, and plant protection problems.

Three experiment stations, each of several hundred acres, have been developed in the central, western and southern provinces of Tanganyika. The headquarters, at Kongwa, include a tented laboratory, a library and a statistical section. These studies have done much to confirm the conclusions of the Wakefield mission on agricultural questions, at least so far as Tanganyika is concerned.

It is true, of course, that the scientific and technical effort will need considerable expansion if the problems of establishing, in a matter of ten years or so, a system of large-scale mechanized agriculture over millions of acres of new land in East Africa are to be dealt with adequately. The need is particularly acute in respect of laboratories. We meet, inevitably, many difficulties of supplies and communications; but we have been well supported by the management of the scheme, whether under the United Africa Company or the Overseas Food Corporation.

Secondly, the many delays and difficulties of the last two years, which are as disappointing to the technical staff as to all other workers on the project, are not in the main due to lack of technical information such as agricultural research can be expected to provide, nor, as has been alleged by some, to disastrous failures on the agricultural side. They arise in great part from engineering problems of clearing, construction, communications and general development, which have proved to be greater than was foreseen, and could not have been eliminated by small-scale research, since they are essentially problems of large-scale operation and organisation in new country. These very delays give us on the research side the more time to press forward our investigations.

This is not to say that the agricultural problems are negligible. They are many and important; some promise to give much trouble. Nevertheless the scientific and technical staff share with Sir John Russell, under whom many of us formerly served, the belief that we shall find the solutions.

A. H. BUNTING
(Chief Scientific Officer)

Overseas Food Corporation,
Kongwa, Tanganyika.
Jan. 24.

APPLICATIONS OF ELECTRONICS TO RESEARCH AND INDUSTRY

THE first Electronics Symposium of the Scientific Instrument Manufacturers' Association was held in the Caxton Hall, Westminster, during November 18–19. Mr. A. G. D. West, chairman of the Electronics Group of the Association, presided at the first session, and the proceedings were opened by Sir Edward Appleton, who expressed his belief in the great existing and potential importance of electronic techniques in industrial processes. He gave instances in which the introduction of such devices had secured savings of time and money out of all proportion to their cost. The Department of Scientific and Industrial Research had set up a small organisation to explore the field of potential application in industry and to advise on the design and supply of electronic equipments appropriate to the various particular problems they encountered.

The first paper in the symposium itself was by D. J. Mynall (British Thomson-Houston Co., Ltd.) on "Electronics in Computing". Present developments in automatic electronic computing machines can be classified as digital or analogic, according to whether they operate on numbers or on continuously variable quantities. The digital type, with its capacious 'memory' based on supersonic delay lines, cathode ray, or magnetic devices, has a very wide range of application, very great speed, and can give any desired accuracy; but its construction is correspondingly complex. Analogue computors, on the other hand, though generally simpler in construction, are inherently limited in accuracy. It was pointed out in the discussion that the larger types of electronic digital computor will open up new fields of pure and applied science, since they will, for the first time, make practicable the solution of problems which would otherwise need a prohibitive time for computation.

In the second paper, entitled "A Review of Frequency Measurement", by E. A. Rea Palmer and R. W. Darvill (Marconi Instruments, Ltd.), the relation between frequency, time and wave-length was discussed, and the customary division of the electromagnetic wave spectrum into bands was considered. Reasons were given for treating frequency measurement on a functional basis, the chief among them being that different accuracies are required in the various fields, which range from power engineering to ultra-high-frequency radio communications. Equipment can be divided into two groups: direct indicators with an accuracy not better than one part in 10^4; and comparison instruments in which the reference standard has a constancy better than one part in 10^7. The types of instruments appropriate to the various fields were enumerated, and some typical models were described and demonstrated. These included an 'electronic' meter of the limiter-counter type, for use at low frequencies, a high-precision comparison instrument for medium frequencies, a frequency synthesizer for high frequencies, tuned lines for very high frequencies and a crystal calibrator for the ultra-high-frequency band.

The first morning session concluded with a paper on "The Measurement of Small Displacements by Electrical and Electronic Means", in which R. E. Reason (Taylor, Taylor and Hobson, Ltd.) explained that transducers of high stiffness, such as piezoelectric crystals, are suitable for measuring force, while transducers of low stiffness, such as photoelectric or electromagnetic devices, are more appropriate for measuring position.

It was pointed out that electronic instruments, although capable of high magnification, are often unsuitable for workshop applications, where the requirements of low magnification, robustness and cheapness are more easily met by simpler electrical devices. On the other hand, certain types of application such as, for example, the measurement of surface finish, require electronic devices, since high magnification with very low stiffness is necessary. Some practical applications of electronic methods were illustrated by reference to various historical and commercial instruments.

Dr. A. J. Maddock took the chair for the afternoon session, which was opened by G. Syke (Baldwin Instrument Co., Ltd.) with a paper on the "Measurement of Ionizing Radiations". He described the operation of an ionization gauge comprising an ionization chamber, a capacitance or resistance, and a potential measuring device, the voltage across the capacitance or resistance being a measure of the dose or dose-rate respectively. Mr. Syke emphasized the advantages of negative feedback circuits in association with electrometer valves, and described several such circuits. Other instruments mentioned were those using vibrating reed electrometers, multiplier photocells, and Geiger–Müller tubes, the last-named being very suitable for detecting traces of radioactive materials. The principle of operation of the tube and its use with electronic pulse counters were described.

In the second paper, by W. Steckelmacher (W. Edwards and Co. (London), Ltd.), on "High-Vacuum Gauges", reference was made to instruments for measuring low gas pressures both in the research laboratory and in industry. For pressures down to 10^{-4} mm. of mercury, the Pirani gauge is valuable and may be used in a Wheatstone bridge network; alternative schemes making use of a thermocouple welded to the filament are available. The cold-cathode glow-discharge tube can be used in the range 5×10^{-3} to 10^{-5} mm. of mercury, an extension of the range to the low value quoted having been realized by the use of a magnetic field and a special electrode array which increases the opportunities for collision and thus augments ionization. Hot-cathode ionization gauges are effective at pressures down to 10^{-8} mm. of mercury under ideal conditions. They are similar in construction to ordinary triodes, but are used with the grid at a positive potential of about 100 volts and the anode at a negative potential of about 20 volts. For the most accurate measurement of very low pressures, the Knudsen gauge, which uses the direct principle of molecular momentum transfer, is recommended.

The McLeod gauge still remains the standard instrument, and may be used for pressures down to 10^{-4} mm. of mercury. The other types of gauges are calibrated by reference to the McLeod gauge, it being necessary at the lower pressure ranges to extrapolate readings. The indications of the McLeod gauge are subject to error when the system contains vapours.

One of the serious difficulties in the use of the ionization type of gauge is the reaction of the gauge on the system. In some cases the pressure in the vicinity of the gauge may be appreciably lower, in others appreciably higher, than the pressure in the rest of the system, depending on whether the gauge is producing gas or 'gettering'. The author indicated a possible error factor of 10, and concluded his paper with the statement that much work remains to be done to eliminate the difficulties at present confronting the accurate measurement of very low pressures.

In the next paper, on "The Radiosonde and its Applications", J. Foster Veevers (Salford Electrical Instruments, Ltd.) gave details of the processes and test procedures now adopted in the large-scale manufacture of the standard British instrument known as the Kew Mark II. This equipment, originally developed at the National Physical Laboratory and later modified by the Meteorological Office, is now in daily use for the collection of upper air data. To obtain a temperature accuracy of ± 1° F., a pressure accuracy of ± 5 millibars and a humidity accuracy of 10 per cent, great care has to be taken in the routine calibration of the instruments, and various special chambers have been constructed for this purpose.

On the second day of the meeting, emphasis was given to industrial applications of electronics, the chairman at this session being Mr. F. A. Downes.

In the first paper, on "Some Industrial Applications of Ultrasonics", D. O. Sproule (Henry Hughes and Son, Ltd.) pointed out that although a vast number of applications have been indicated in the literature, relatively few have so far resulted in devices of commercial value. The marine echo sounder was described and demonstrated, and extensions of its principle for industrial purposes were discussed, with particular reference to the location of flaws and the determination of the elastic constants of materials. The technique of non-destructive flaw detection was demonstrated, and the deduction of the elastic constants of a material from measurements of the velocity of propagation of both longitudinal and transverse vibrations was described. The process of grain refinement was outlined as a typical example of an application in which the objective is a permanent modification of the medium.

In the second paper, by G. S. Elphick, S. Y. Logan and A. R. Woods (Cinema Television, Ltd.), entitled "Metal Detection in Industry", an outline was given of the development of metal detection technique, from the war-time requirements of mine- and bomb-location to the latest industrial equipments currently in use. After summarizing present-day requirements, three detectors were described and the principles involved in their design were explained.

The first is a general-purpose detector of the regenerative type, for use in saw mills for locating metal in timber. The second is a variation of the first, and has been designed for pipe- and cable-location; while the third is a fully automatic industrial equipment in which frequency drift is automatically corrected. In this last instrument ferrous particles about $\frac{1}{16}$ in. in diameter or non-ferrous particles $\frac{1}{10}$ in. in diameter can be detected in materials travelling along a conveyor belt. This apparatus is finding increasing use in a wide range of industries as an inspection device, affording continuous protection for valuable plant, and an effective safeguard against the inclusion of metal in foodstuffs, pharmaceutical products, etc.

Introducing the third paper, on "Sound and Vibration Measurement in Industry", L. P. Corte (Dawe Instruments, Ltd.) stressed the increasing importance of noise control in industry, the first step towards which was the measurement of noise and vibration. He distinguished between the objective characteristics of noise, such as total intensity and the distribution of intensity with frequency, and the subjective characteristics such as loudness, pitch and annoyance. A range of instruments for objective measurements was described. A sound-level meter utilizing a piezo-electric microphone in conjunction with an amplifier and rectifier to measure the total intensity was described. In this instrument some account is taken of the characteristics of hearing, since the resistivity to low frequencies can be reduced at low intensity-levels in accordance with that of the ear.

A vibration meter was next described in which a piezo-electric pick-up is employed, of which the response is proportional to acceleration. A description was then given of an analyser which could be used with either the sound-level meter or the vibration meter. Finally, for the production of permanent records, a level recorder of the Neumann type was described, which gives a record on waxed paper on a decibel scale. A demonstration of the reproduction of the noises of trains, trams, etc., was much appreciated.

The chairman for the afternoon session was Mr. F. D. Hart, and a paper on "Electronics in Spectroscopy" was read by F. Holmes (Hilger and Watts, Ltd.). The development of direct-reading methods of spectrochemical analysis was outlined under the main headings of photocells, photomultiplier tubes, and thermopiles.

In Great Britain the lack of generally available photomultiplier tubes has caused attention to be directed to cæsium-type photocells; whereas in the United States complex and costly direct-reading spectrographs, based on photomultipliers, have been marketed. It is hoped that the supply position will be remedied by British manufacturers in the near future, although it still remains to be proved that the fundamental properties of this equipment offer any increase in accuracy over photographic recording for quantitative spectrographic analysis, and the advantage of speed of response may be illusory in view of rapid and localized fluctuations at the source.

For work in the infra-red region, a high-speed thermopile was described with a 90 per cent response within 15 milliseconds and an output of 50 microvolts per microwatt. A diagrammatic circuit of a direct-reading infra-red spectrometer based on this thermopile and a cathode ray tube was shown, and a separation of eight wave numbers at 10μ was claimed.

The lack of suitable ratio recorders was emphasized as a drawback to the double-beam system, and an outline of a suitable phase-sensitive recorder shown.

The final contribution to the symposium was by J. Bell (Muirhead and Co., Ltd.), who described "Some Developments in Picture Telegraphy". This paper, which was concerned entirely with the British equipment manufactured since the end of the War, has already been referred to in *Nature* of January 22, p. 145. At the symposium Messrs. Muirhead and Co. exhibited fixed and portable equipments, together with samples of pictures actually transmitted over telephone lines.

DUST IN INDUSTRY

CONFERENCE AT LEEDS

ABOUT two hundred delegates attended the Conference on "Dust in Industry" which was organised by the Society of Chemical Industry and held at the University of Leeds during September 28–30. The papers presented during the five sessions of the Conference covered a wide range of subjects and showed how dust problems enter into almost every major industrial process.

After a civic welcome by the Lord Mayor of Leeds, the delegates proceeded to the business of the first session under the chairmanship of Prof. H. V. A. Briscoe. Under the general title of "The Physical Characteristics and Estimation of Dust" the following four papers were presented: "Problems on the Design of Plant Handling or Producing Dust", by G. Nonhebel "A Rapid Method of Dust Estimation in Iron and Steel Foundries", by B. W. Lawrie; "Dust Hazards in the Explosives Industry", by Prof. W. M. Cumming, Dr. F. Rumford and Dr. W. G. D. Wright; and, finally, "Particulate Clouds in the Gas Industry", by E. H. M. Badger.

Mr. Nonhebel made a broad survey of the processes in the production or control of fine particles. From his review of the factors concerned in such operations as grinding and classification, the separation of dusts from gases and liquids, mixing, aggregation and the size analysis of dust samples he pointed out the lack of knowledge in this field and the vast amount of fundamental work which is needed before the design of plant for such purposes can be established on a sound scientific basis.

Mr. Lawrie described a quick method of dust estimation suitable for survey work in iron or steel foundries or other industries where the dust concentrations encountered are so great that counting of samples taken by the thermal precipitator is frequently impossible. In brief, samples collected by the thermal precipitator or by the Owens jet counter are photographed on a projection microscope and compared visually with a standard scale of dust concentrations. While admittedly this method gives only an estimate of the dust concentration, it is claimed that it is entirely adequate for comparing the efficiency of dust control systems and that it gives as good an indication as may be obtained of the health risk in an industry. This work has shown, incidentally, that more accurate estimates of thermal precipitator slides can probably be made by counting a photographic record rather than by the usual direct visual count.

Prof. Cumming discussed the three main dangers of excessive dust concentrations in explosives factories—ignition, health hazards from contact or by inhalation of the dust, and dermatitis. Trinitrotoluene and tetryl show all these three dangers to a greater or lesser extent. He described a simple photo-electric method used for measuring the relative 'dustiness' of explosives, and also gave an account of colorimetric methods devised for estimating the concentration of airborne dinitrotoluene, trinitrotoluene and tetryl sampled by the standard D.S.I.R. pump. Trinitrotoluene and tetryl are absorbed in a mixed solvent of methyl ethyl ketone and *cyclo*hexanone containing a little potassium hydroxide, and estimated by comparison with standard colour disks.

Mr. Badger described how, in the separation of dust from producer-gas, trouble was experienced with the formation of stalactitic growths across the electrostatic precipitator plates. The difficulty has been overcome by the evaporation of a small amount of tar oil into the gas. This condenses and forms a liquid film around the dust particles, rendering the deposit fluid enough to run off the plates. Removal of much tar fog from gas takes place in the exhausters; but particles of above a certain critical size only are removed. The tendency for spontaneous condensation, producing small droplets, can be minimized by mixing pre-cooled gas with the main gas stream, thus introducing nuclei for condensation. A portable electrostatic precipitator used during this work was described.

The discussion centred around Mr. Lawrie's paper. The chief criticism of his method was that it does not differentiate chemically between the particles present in foundry dusts. The health hazard is primarily dependent on the silica content and not on the total dust count. The suggestion that it is a quick method suitable for use in dust surveys was endorsed by several speakers.

The second and third sessions, under the chairmanship of Dr. Julian M. Leonard and Mr. A. V. Hussey, were both devoted to "Practical Aspects of the Dust Problem". The four papers given during the second session were "Some Methods of Reducing Contact with Dusts in Chemical Manufacture", by L. Marsden, G. W. Robertson and Dr. R. A. Storey; "The Problem of Dust in the Chemical Industry", by G. Lowrie Fairs and E. Godfrey; "The Problem of Dust in the Cotton Industry", by Dr. D. W. Hill; and "Some Practical Methods of Industrial and Atmospheric Dust Elimination", by J. H. Hellyer and J. Cleeve.

Dr. Storey considered means of preventing the formation of, and removing, air-borne dust at its origin in a variety of unit operations involving the charging, processing and discharging of dry materials. He suggested that dealing with the problem in this way is preferable to applying individual protection for each operator.

Mr. Lowrie Fairs divided dust problems into three types and suggested means of dealing with each of them: (*a*) where dust produced at one stage may interfere with later stages in a process; (*b*) where escape of dust causes atmospheric nuisance; and (*c*) where atmospheric dust entering a plant may cause contamination of a product. The possibility of obtaining large flows of sterile air by filtration through 'Stillite' blocks was mentioned.

Dr. Hill reviewed the causes of dust production in the cotton industry and the problems arising therefrom. Operatives are liable to suffer from a respiratory disease known as byssinosis after long exposure to the dust liberated during the opening and carding operations. Little is known about the active agent in the dust, but it is evidently to be found in the finer fractions and may be histamine, lipoids, fungi or proteins which are potential allergens. The problem is one of removing the harmful dust without contravening strictly defined conditions of temperature, humidity, freedom from strong draughts and adequate access to machines.

Mr. Hellyer reviewed modern apparatus for the collection of dust from industrial gaseous effluents and for the cleaning of atmospheric air during conditioning. He dealt most fully with the design, operation and characteristics of electrostatic precipitators. A recent type, the 'Precipitron', was designed for air-conditioning plant. Ionization takes place in this precipitator at a potential of 14 kV. and collection at 7 kV. Ionizing wires and charged plates are both positively charged, rendering ozone formation very small. A blackness test, using filter-paper disks, was described for measuring efficiencies. Numerous photomicrographs of industrial dusts were shown.

Points raised during the discussion on this session included the possibility of using oil treatment of the cotton during carding, recent experiments having shown very promising results. The high installation costs and the apparent drop in efficiency with time of electrostatic precipitators were mentioned by several speakers.

The three papers presented during the third session were "Practical Aspects of the Dust Problem, with Particular Reference to Flour Milling", by Leslie Smith; "The Dust Problem in the Photographic Industry", by R. G. R. Carnall; and "Surface Area in Dust Control", by P. J. Rigden.

Mr. Smith outlined present-day practice in dust control in flour-milling processes. High-speed exhaust systems with metal trunking and suction-type fabric filters are favoured. Current trends towards pneumatic conveyance of mill stock may necessitate installing complete air-conditioning plant.

Mr. Carnall presented the unique problem of preventing dust particles from reaching surfaces which could not be better designed to hold them. The solution lies in segregating dirty and clean work, providing special clothing for personnel and paying special attention to their health, forbidding the use of cosmetics and ointments, and using machinery as fully automatic and instrumented as possible. Bag filters, or the new 'Airmat' cellulose-wool filters, are used for air filtration because of their great reliability over long periods. Means of identifying dust particles embedded in photographic emulsions were described and illustrated by many photomicrographs.

Mr. Rigden described a method of measuring the surface area of dust samples, based on the well-known air-permeability method, but requiring samples of only 50 mgm. The pressure drop across beds of powder of sufficient length for accurate measurement is very high and necessitates special methods of measuring the flow of air. Direct weighing of air flowing through the bed into an evacuated bulb and the rise in pressure in such a bulb are the two methods used. Good reproducibility and agreement between the normal method using 10-gm. samples and the new method are attained.

Discussion during the third session showed particular interest in the methods used for dust suppression in the photographic industry. Many questions of detail were asked regarding the effect of sneezing and use of handkerchiefs and the precautions necessary during maintenance and overhauls.

The fourth session, which dealt with "Fire and Explosive Hazards", was held on the afternoon of September 29 under the chairmanship of Lieut.-Col. Sir Reginald Thomas. Six papers, which divided themselves naturally into three groups by their subject-matter, were presented, and discussion took place after each group.

The first two papers were "The Lower Inflammable Limit of Explosive Dusts and the Influence ofDiluents Thereon", by Dr. J. E. Garside; and "Gas Explosions and Dust Explosions, a Comparison", by Elwyn Jones and A. Grenville White.

Dr. Garside described a method of determining the lower limit of inflammability of dust–air mixtures. The dust is dispersed by violently displacing into the explosion vessel a felt pad supporting the dust from a lead tube down which a detonation wave is injected from an exploding air–gas mixture. The method is used to show how the lower limit varies from material to material, is dependent on the grain size of the dust, and can be raised to a safe value by mixing inert powders, such as limestone, with the dust.

Mr. Jones maintained that flame propagation in dust explosions as well as in gas explosions is a thermal process capable of interpretation in terms of calorific value of the mixture. Impossibility of obtaining a perfect mixture of solids and gases complicates combustion in dust explosions. It seems that, at lower limits, solid particulate fuels are capable of forming local centres of ignition and propagation. An important factor in this process may be the volatility of the fuel. An appendix described an apparatus for determining limits of inflammability, which largely removes the influence of settling-rate of the dust.

In the discussion doubts were expressed about the validity of the results obtained in a laboratory-scale experiment when applied to large-scale explosions, and on the possibility of obtaining an accurate figure for the concentration of dust at the time of explosion.

The second group of papers comprised "The Ignition of Dust Clouds by Electrostatic Discharges", by Prof. E. G. Cox and A. G. Peace; and "Coal Dust Explosions. Recent British Experiments", by Dr. F. V. Tideswell.

Prof. Cox, describing work done during the Second World War, showed that many dust clouds might be ignited by electrostatic discharge. The incendivity of a spark depends upon its characteristics, and such a spark has an optimum incendivity when in series with a resistance of value depending on the capacity being discharged. Thus a discharge from a movable bin or from operatives which are badly earthed or from a charged body to an imperfectly earthed conductor is very liable to cause dust explosions.

Dr. Tideswell stressed the real danger of explosions due to coal dust not only in mines but also in pulverized fuel plants. Some amelioration of the danger in mines is to be expected from the increase in wet-cutting and the spraying of coal in tubs and at loading points. Powdered hydrates such as gypsum are more effective in suppressing dust explosions than shale dusts, and their use would increase the margin of safety given by the statutory stone-dusting requirements. Work is proceeding on specially free-flowing stone dusts which will be easier to apply continuously.

The final two papers of this session were "Explosion Reliefs on Dust Plant", by Dr. D. Matheson; and "Precautions Against Fire and Explosion" by G. V. Thom and G. A. V. West.

Dr. Matheson said that in the present state of knowledge the safest thing to do is to build a dust plant strong enough to withstand full explosion pressure, or place it where it can blow up without causing other damage. Work now proceeding should enable explosion reliefs to be designed which will safeguard existing types of plant from bursting through internal dust explosions.

Mr. G. V. Thom presented a very full survey of the explosion and fire hazards met with in chemical industry. He stressed the importance of properly maintaining fire-fighting appliances and of instructing personnel in their use.

A report of the proceedings of Section V of this Conference has already appeared in *Nature* (January 15, p. 111).

CHEMICAL CONSTITUTION AND BIOLOGICAL ACTIVITY

PROGRESS in the interpretation of biological results in terms of chemical constitution is very slow. Except in chemotherapeutic investigations, attempts to correlate physical and chemical data with activity on animal tissues have proved disappointing, even allowing for the relatively low degree of accuracy in biological methods and the too frequent absence of specific knowledge of the mode of action.

At the present time some advances have been made by using drugs belonging to a homologous series, or containing different elements but possessing varying degrees of similar pharmacological activity. Furthermore, lines of research have been directed with drugs having similar structures but showing protagonist and antagonist action. When Dr. F. Bergel delivered his address on "Some Aspects of the Relationship between Chemical Constitution and Physiological Activity" to the Fine Chemicals Group of the Society of Chemical Industry on November 26, 1948, at the London School of Hygiene and Tropical Medicine, he mentioned that too much must not be expected from one or two series of data disclosing only a fraction of the overall constitution. Once a working hypothesis of mechanism of action is established, correlation should be attempted between physico-chemical measurements and biological activities.

During the course of his address, Dr. Bergel showed that, in the consideration of the validity of the expression connecting physiological action of a drug and its chemical constitution (Crum-Brown and Fraser, 1869), it is necessary to include those events which precede visible pharmacological effects. The picture is confusing; but two working hypotheses help to elucidate the mechanism of drug action. In the first or receptor theory, certain areas of the cell at the site of action combine with the drug, and these combinations are the cause of the biological action. Many drugs such as anæsthetics, analgesics, and autonomic derivatives, acting rapidly and in high dilutions, may find their receptors on the outside of the cell surface, while those influencing cell division or growth may react with constituents of the protoplasm. Methylene blue, with its atropine-like and anti-bacterial effects, provides a clear example of both external and internal reactions. In the second or enzyme receptor theory (supported experimentally by such work on B.A.L., inhibitors of cholinesterases, respiratory enzyme systems, and amino-oxidases), a number of these receptors are said to be identical with functional enzymes or proteins. Then, on the basis of competitive affinity and mass action, an explanation is possible for the selective potency of stereoisomers, the increase of activity in homologous series, and the antagonistic action of certain drugs similar to protagonist molecules. The fact that low concentrations of many substances may produce physiological stimulation or depression while higher concentrations cause the reverse effect is, however, not easy to explain.

Turning to the chemical side, Dr. Bergel stressed that, only with models based on correct inter-atomic distances, van der Waals radii and valency angles, apart from geometrical and optical isomerism, can the compactness and spatial distribution of the atomic aggregate be appreciated. In addition, the existence of electrovalent, covalent and co-ordinate bonds, lone electron pairs, bonds with dipole moments adding up to polar groups and to polarization of the molecule, oscillating dipoles, resonance and hydrogen bonding, must not be forgotten. It has already been shown in some series that a certain bond-distance appears to be optimal for maximal effects. But disappointing results have been obtained from other aspects, and pharmacological chemists have therefore had to rely on rather more empirical approaches. The aim has often been to find a pharmaco-dynamic group, that is, the structural minimum which still carries distinct activity, and this type of method is well illustrated by work on synthetic analgesics, such as morphine substitutes.

G. B. WEST

GERMAN SOCIETY FOR DOCUMENTATION

CONFERENCE AT COLOGNE

BEFORE the Second World War, the International Federation for Documentation, then the International Institute of Documentation, included a German section which, afterwards, was converted into a purely German affair under the Nazi regime. A conference of the Deutsche Gesellschaft für Dokumentation took place in Salzburg in 1942.

During December 9–10, 1948, at Cologne, another conference was held, the first since the War, with the aim of finding the way back to the broader outlook which might once again open up possibilities of international co-operation in the field of documentation. It was a re-organised Deutsche Gesellschaft für Dokumentation which sponsored this Conference, together with the Deutsche Normenausschuss, the Verband der Bibliotheken von Nordrhein-Westfalen, the Arbeitsgemeinschaft der Technisch-Wissenschaftlichen Bibliotheken and the Verein Deutscher Archivare. The Conference was attended by some 150–200 delegates from different parts of Germany, representing universities, libraries, learned societies, the legal profession, designers of apparatus, and industrial bodies, meeting on board a middle-size river boat equipped as hotel and restaurant.

The opening session was presided over by Prof. Schmölders, who welcomed the delegates on behalf of the rector of the University of Cologne, Prof. Kroll. The main speakers of this session were Dr. Vollmer, director of the Staatsarchiv at Düsseldorf, and Prof. Corsten, director of the Stadt- und Universitäts-bibliothek at Cologne. It was followed by a business meeting of the newly constituted society, election of officers, the formation of sub-committees and so on. Lectures, open to the public, were given at the University of Cologne by Dr. W. Schürmeyer, president of the Deutsche Gesellschaft, Mrs. L. Moholy, representing the Library Association and the Royal Photographic Society of Great Britain, and Dr. Pierre Bourgeois, director of the Bibliothèque Nationale Suisse.

The emphasis of the lectures, papers and subsequent discussions was on the various aspects of microphotography, its growth and development, its progress in different countries, its use in archives, libraries and bibliographical centres, its importance for scholars, scientific and research workers, the copyright position, and so on. Two copyright experts, Dr. O. Runge and Dr. Wildt, advocated the setting up of central agencies to simplify procedure (a suggestion also recommended in Great Britain), especially in cases where speed is essential. Prof. E. Reimer, another authority on the subject, was unable to attend.

To some extent the problems attached to the use of microfilms in Germany have been similar to those in Great Britain, though where the British often hesitate, the Germans have made quick decisions, and a variety of answers now strive for co-ordination. The requirements of *ad hoc* copying are distinct from those which govern organised reproduction; but any solution must keep within the provisions of a restricted economy. There seems to be scope for transparent as well as opaque material, flat shapes as well as long lengths, celluloid and 'Cellophane', high- and low-reduction ratio, microfilm with or without perforations, microcards, miniature prints, and so on, with the limitations mainly imposed by dearth of machinery.

To keep in check and, if possible, to standardize the existing variety of experimental methods, were among the aims the Conference set out to achieve. Apparatus, material and samples of work done were on view, to give practical backing to a number of technical points. It was, however, realized in the course of discussions that account must be taken of corresponding efforts carried on outside Germany, if international co-operation is to be restored, this being the other objective foremost in the minds of those who organised the Conference. The presence of foreign guests, including Mr. Donker Duyvis, general secretary of the International Federation for Documentation, to whom the Deutsche Gesellschaft für Dokumentation has now applied for re-affiliation, was welcomed as a hopeful sign in this direction.

L. Moholy

PHYSICS IN GERMANY

A DISCUSSION about the claims of technical physics to be regarded as a subject in its own right began at the International Congress for the Training of Engineers in Darmstadt in 1947, and has been carried on in *Physikalische Blaetter* (No. 8, 253; 1947. No. 1, 16; 1948. No. 3, 110; 1948), and is still going on.

Prof. C. Ramsauer, an eminent 'technical physicist' himself, founder and director of the A.E.G. Research Station, is emphatically opposed to the idea of technical physics as a special subject, although formerly there was a society devoted to it of which Prof. Ramsauer was president. Prof. Ramsauer states that during the First World War, both industrial and Government authorities were surprised at the superiority of 'pure physicists' over engineers in the solution of technical problems. Soon it was generally recognized that where new ground is to be tilled, it is not the routine of the engineer but the comprehensive grasp of fundamentals that assures success. The teaching of engineers, he believes, should be the same as that of all other physicists, supplemented in the advanced stages by technical courses not occupying more than one third of the total time, this total excluding mathematics and chemistry but including physical chemistry. The most grievous injury inflicted on German science by the Nazi regime was the substitution of the diploma examination for the doctor's dissertation; an examination deals with present knowledge whereas the thesis teaches the student to explore the unknown.

The opposite view has been advocated by Prof. Vieweg. He maintains that 'technical physics' must be a separate subject from the start. The technical physicist is a liaison officer between physics and engineering. Prof. Vieweg believes there should be mutual fertilization, and the term 'technical physics' expresses better than 'applied physics' this reciprocity. The task of technical physics is to loosen up and prepare the ground for technical development.

Prof. Ramsauer, after quoting replies to a questionnaire, most of which share his view, invites university authorities and industrial leaders to express their opinion about some concrete proposals which he sets forth. These include the demands that the term 'technical physics' should be completely dropped and that, as before, the doctor's degree should be the natural goal of every physicist's training. He calls this a matter of life and death for German science.

The Deutsche Physikalische Gesellschaft in der britischen Zone has declared at its board meeting of September 8, 1948, that it adopts the views of Prof. Ramsauer. It is of the opinion that there is no 'technical' physics, but only physics; technical physics is nothing but the application of pure physics to technical problems, and no special syllabus is required for such purposes. The Society considers that the introduction to technical mechanics and into electrotechnics should be taught at universities. Special technical problems ought to be dealt with in accordance with local conditions; however, they must not endanger the thoroughness of the general scientific education.

The obligatory doctor's dissertation is regarded as most important; its abolition during the Nazi regime was a great misfortune. The Society is most anxious that the 'diploma examination' should again be replaced by the 'doctorate examination'. In the meantime, it requests all authorities and firms to give preference to candidates who have obtained the doctor's degree. Gratification was expressed at the board meeting that its views are approved by the most important industrial firms.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 19

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 10 a.m.—Discussion on "Layout and Planning for Radiographic Inspection".

Monday, February 21

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. H. G. Thornton, F.R.S.: "The Ecology of Bacteria with Especial Reference to Soil".* (Further Lectures on February 28 and March 14.)

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Dr. W. H. J. Vernon: "The Corrosion of Metals". (Cantor Lectures.) (Further Lecture on February 28.)

Royal Geographical Society (joint meeting with the Royal Society, at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Hans Pettersson: "Exploring the Ocean Bed".

Tuesday, February 22

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. W. G. Archer: "Primitive Indian Pottery".

Institute of Sociology (at the Royal Institute of British Architects, Portland Place, London, W.1), at 5.30 p.m.—Dr. G. Scott-Williamson: "The Family as a Basis of Society".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Automatic Precision Instruments" (to be opened by Dr. A. T. Starr).

University of London (in the Department of Botany, King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. G. E. Blackman: "Modern Selective Weed Killers".*

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 6 p.m.—Papers on "The Spekker Photoelectric Absorptiometer and Fluorimeter".

Society of Chemical Industry, Fine Chemicals Group (in the large Anatomy Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; at 7.30 p.m.—Discussion on "Process Research in the Fine Chemical Industry" (to be opened by Dr. H. J. Barber, Dr. G. M. Dyson and Mr. F. J. Bolton).

Institution of the Rubber Industry, Scottish Section (at the Chamber of Commerce Rooms, Charlotte Square, Edinburgh), at 7.30 p.m.—Dr. W. McG. Morgan: "Accelerators for Stocks containing Reinforcing Furnace Blacks, Part 1, The Scorch Problem".

Wednesday, February 23

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Dunstan Skilbeck: "Training for Agriculture".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Linnean Society of London (in conjunction with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. K. Airy Shaw: "Post-Darwinian Development of Taxonomy (Botany)".

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Dr. W. J. S. Naunton: "Rubber and Chemistry".

Society of Chemical Industry, Food Group (joint meeting with the Royal Entomological Society of London, at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 6 p.m.—Dr. Colin G. Butler: "Some Observations on the Sense Physiology of the Honeybee"; Mr. J. Pryce Jones: "The Origin, Composition and Properties of Honey".

Thursday, February 24

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Hartley, F.R.S.: The Berzelius Memorial Lecture.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Evolutionary Aspect of Colour Vision" (to be opened by Dr. P. J. Pumphrey).

University of London (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S.W.1), at 5 p.m.—Prof. B. G. Maegraith: "Malaria as a World Problem".*

Institution of Chemical Engineers (joint meeting with the Low Temperature Group of the Physical Society, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. E. W. Colbeck: "Materials of Construction for use at Low Temperatures".

Chemical Society, Hull Section (joint meeting with the Hull and District Section of the Royal Institute of Chemistry and the University College Scientific Society, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. M. Polanyi, F.R.S.: "The Nature of Scientific Convictions".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. W. J. Duncan, F.R.S.: "Flutter and Stability".

Chemical Society, Nottingham Section (joint meeting with the University of Nottingham Chemical Society, in the Chemistry Department, the University, Nottingham), at 6.30 p.m.—Prof. C. A. Coulson: "The Shape of the Chemical Bond".

Chemical Society, Manchester Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Dr. R. P. Linstead, F.R.S.: "Some Recent Developments in Organic Chromatography".

Chemical Society, Edinburgh Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Mr. R. C. Chirnside: "Analytical Chemistry, Chemical Analysis and the Analyst".

Friday, February 25

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Chemical Society, St. Andrews and Dundee Section (joint meeting with the Royal Institute of Chemistry and the University Chemical Society, in the Chemistry Department, United College, St. Andrews), at 5.15 p.m.—Prof. C. E. H. Bawn: "Free Radicals and Hydrocarbon Chemistry".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. P. Draminsky (Copenhagen): "Crankshaft Damping".

Chemical Society, Aberdeen Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. D. H. Everett: "Some Factors Influencing the Strength of Acids and Bases".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Hans Pettersson: "Through Three Oceans with the *Albatross*".

Saturday, February 26

Association of Scientific Workers, Agricultural Section (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 3 p.m.—Dr. Audrey Richards: "Problems of Colonial Development—an Anthropologist's Point of View".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Principal Scientific Officer in H.M. Nautical Almanac Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2404 (February 25).

Principal Scientific Officer in the Magnetic and Meteorological Department at the Royal Greenwich Observatory—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2402 (February 25).

Metallurgist (Ref. F/EV.36), an Analytical Chemist (Ref. F/EV.46), an Assistant Chemist (Ref. F/EV.47), and an Assistant (with good honours degree, or equivalent, with physics as the main subject) (Ref. F/EV.48), in the Central Laboratory at Chiswick—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting appropriate Ref. No. (February 26).

Senior Lecturer in Chemistry at the Military College of Science, Shrivenham, near Swindon—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.38/49A (February 26).

Assistant Keepers (Class II) in the Departments of Chemistry, Optics, Astronomy and Mathematics—The Director and Secretary, Science Museum, South Kensington, London, S.W.7, endorsed 'Assistant Keeper' (February 28).

Bradford Dyers' Association Fellowship for research on fundamental problems in the industrial processing of textiles—The Registrar, College of Technology, Manchester 1 (February 28).

Head of the Electrical Engineering Department—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (February 28).

Senior Lecturer in Agriculture at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 28).

Principal Scientific Officers, Senior Scientific Officers, and Scientific Officers, at the Royal Aircraft Establishment, Farnborough, Hants, for work in connexion with the planning of future aircraft projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.451/48A (February 28).

Readership in Taxonomy in the Department of Zoology at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 4).

Professor of Geology, and a Lecturer in Geology—The Registrar, University College of South Wales, Cathays Park, Cardiff (March 15).

Chair of Physiology at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 31).

Lecturer in Acoustics, and an Assistant Lecturer, in the Department of Physics—The Registrar, The University, Liverpool (April 2).

Beit Fellowships for Scientific Research—The Registrar, Imperial College, South Kensington, London, S.W.7 (April 2).

Senior Lecturer in Pure Mathematics, and a Lecturer in Applied Mathematics, at the University of Natal, Pietermaritzburg; and a Senior Lecturer in Applied Mathematics, at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.2 (April 11).

Chair of Geology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (April 16).

I.C.I. Research Fellowships for research in Physics, Chemistry, Biochemistry, Engineering, Metallurgy, Pharmacology, Chemotherapy, or related subjects—The Secretary, Board of Research Studies, The Old Schools, Cambridge (April 30).

Senior Chemist to the Rubber Research Scheme (Ceylon)—The Chairman, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7 (April 30).

Beit Memorial Fellowships for Medical Research—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (May 14).

Head of the Mathematics and Physics Department, Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1.

Scientific Assistant for information service and abstract journal—The Director, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9.

Senior Entomologist and Field Entomologists (3) in the East Africa Desert Locust Survey—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in the Department of Chemistry, Colour Chemistry and Dyeing—The Registrar, Technical College, Queen Street South, Huddersfield.

Senior Assistant in Physics in the Darlington Technical College—The Chief Education Officer, Education Offices, Northgate, Darlington.

Superintending Pharmaceutical Chemist by the Government of the Federation of Malaya for Medical Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 18288.3F.

Mineralogist Chemist in the Geological Division of the Lands and Mines Department of Tanganyika—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Assistant Professor who is an honours graduate in Mechanical Engineering, and Lecturers (2) with honours degrees in Mathematics (one Lecturer with an honours degree in Electrical Engineering or an equivalent qualification, one Lecturer with an honours degree in Metallurgy or an equivalent qualification), at the Royal Naval College, Greenwich—The Secretary of the Admiralty (C.E. Branch 1), Admiralty, London, S.W.1.

NATURE

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ANGLO-AMERICAN CO-OPERATION IN COLONIAL DEVELOPMENT

THE developments in the campaign against the tsetse fly in Central Africa, and the recently published report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast (see *Nature*, January 15 and 22, and February 19), have emphasized the importance of the contribution which science has to make to the health and development of the backward territories, and through them to human welfare generally. Furthermore, the very nature of the latter Commission, consisting as it did of scientific men selected from a list prepared by the United Nations Food and Agriculture Organisation, demonstrates the value of international co-operation in this field; and especially of regional developments, such as the conferences with the French, Belgian and Portuguese Governments, and the discussions with the French Government and other associated Governments on the possibility of co-operation in development schemes to which the Colonial Secretary, Mr. Creech Jones, referred in a House of Commons debate on Colonial affairs last July. Mr. Creech Jones clearly recognized that in such areas as West and Central Africa, co-operation between these Powers in tackling the fundamental problems of Colonial development is all-important.

The fourth proposal made by President Truman in his inaugural speech on January 20, namely, that the United States should embark on a bold new programme for making the benefits of her scientific advances and industrial progress available for the improvement and growth of under-developed areas, will therefore be widely welcomed. Mr. Truman said :

> "More than half the peoples of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to more prosperous areas. For the first time in history humanity possesses the knowledge and skill to relieve the suffering of these peoples.
>
> "The United States is pre-eminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for the assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible. I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge . . . and in co-operation with other nations, we should foster capital investment in areas needing development. Our aim should be to help the free peoples of the world, through their own efforts, to produce more food, more clothing, more materials for housing and more mechanical power to lighten their burdens. We invite other countries to pool their technological resources in this undertaking. Greater production is the key to prosperity and peace. And the key to greater production is a wider, more vigorous application of modern scientific and technical knowledge."

This invitation to a co-operative enterprise in which all nations work together through the United Nations and its specialized agencies, wherever practicable, could scarcely have been issued unless there lay behind it the draft of a project in which ways and means are dealt with in considerable detail. It is true that President Truman linked this proposal with the continuance of support of the United Nations and of the European Recovery Programme as well as with the support of freedom-loving nations against aggression by regional pacts, such as those embodied in the treaty of Rio de Janeiro or at present being worked out for the North Atlantic Area. Nevertheless, it is not easy, even with the precedent of the Colonial Development Corporation before us, to visualize the exact means by which this idea of co-operative capital development can be made to work.

Capital investment is admittedly one of the fundamental needs of the backward areas ; but even if the proposal means that the United States are prepared to take over the role of leadership in this century which Britain filled in the last, the task is immensely more complicated. Against the greater advantages and resources for human welfare which science and technology have given us to command, there have to be set the growth of nationalism and the extent to which the expectations of the under-privileged everywhere have been magnifying the standards achieved in more prosperous countries. Even without the existence in Communism of a political force which not only makes these aspirations articulate but also may confuse the issues to support a rival bid for world leadership, the task of reconciling opposing, or apparently opposed, interests will be far from easy. The report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast provides sufficient illustration of the way such considerations may intrude on a purely scientific or technical problem.

Mr. Truman's statement was warmly welcomed by the Foreign Secretary, Mr. Bevin, in his speech to the Foreign Press Association on January 25. Mr. Bevin thought that all the Powers responsible for overseas territories would throw into the pool all the knowledge, ability and resources they had at their command. Successive Colonial Secretaries have already made plain the readiness of Britain to associate herself with schemes of regional development in the Caribbean, Africa and elsewhere, while at the same time dissociating themselves from any idea of international government. Discussions, in fact, have already taken place in Paris on the possibility of closer economic co-operation between France and Great Britain in their Colonial territories.

Unfortunately, the Trusteeship Council of the United Nations has so far conspicuously failed to win the respect accorded by the Colonial as well as the Mandatory Powers to the Permanent Mandates Commission of the League of Nations. Time will be required to dispel the suspicion that the new Council is being used mainly as a sounding board for irresponsible and destructive criticism and not as an organ of co-operation. Meanwhile, quite apart from the fact that the whole trend of President Truman's statement indicates that he is prepared to use other agencies where the specialized agencies of the United Nations are ineffective, there has already been demonstrated a growing measure of international co-operation in the scientific and technical field, and it is on this field that President Truman laid particular stress. No such obstacles as may beset the proposition for co-operative capital development, with the necessity for dovetailing such projects very carefully with the demands made under the Marshall Plan, need hinder the spread of technical knowledge in these undeveloped areas.

That in itself is a long-term project which will require time for fruition. There are, however, various ways in which the United States could probably render immediate and direct assistance. Thus it could share its own pre-eminent development of industrial and scientific techniques at no great cost by broadening the facilities offered to students of all nations to study in the universities and technical institutes of the United States. This would do much more than simply ease the great strain placed on the over-crowded universities of Great Britain through the admission of increased numbers of overseas students and co-operation in the development of the new universities throughout the Colonial Empire. The students may be expected to carry back to their own lands both knowledge and also an enduring appreciation of the American way of life.

Whether such help is given in the form of men and women, or of space in educational institutions, or of finance—and in few fields could a relatively small financial outlay bring such a large return—it can only be welcomed by Britain and other Colonial Powers. At first, indeed, it can only be on a small scale, for students well equipped to profit by the opportunity will not easily be found until education has further advanced in the African and other backward territories concerned. Some part of the American effort might accordingly take the alternative form of assisting educational enterprises in lands that have not the resources to break the fetters of illiteracy for themselves.

Significantly enough in this connexion, it may be recalled that the Colonial Office has already asked the United States Economic Co-operation Administration whether American men of science and technicians could fill posts in the Colonial Geological Survey and the Colonial Geodetic and Topographical Survey until the recruiting position caused by the gap in training during the war years improves. The vacancies are for reconnaissance work required before new areas can be opened up for mineral and other development, and the recruitment of some fifty Americans in this way would be a notable step in the pooling of experience. It would be a manifestation of Anglo-American partnership in service which might well contribute to the spread of Anglo-American ideas and principles in a way comparable to the permeation of Indian thought in the last century by the ideas of British educationists.

President Truman's proposal should give a further stimulus to the zeal and enthusiasm lying behind some of the striking achievements of science and technology, which are opening up new opportunities for human welfare and economic development in Africa, and to the international and regional co-operation required to realize those possibilities. It should be remembered that, more than a year ago, in a speech in the House of Commons on January 22, 1948, the Foreign Secretary linked the development of the backward areas with the economic recovery of Western Europe. The imaginative passage in which Mr. Bevin urged the closest possible collaboration between the British Commonwealth and French, Dutch, Belgian and Portuguese as well as British overseas territories, should be set beside Mr. Truman's recent proposal.

Neither Mr. Truman nor Mr. Bevin pursued the idea into any detail. Mr. Bevin was content to emphasize that there is no inherent conflict between the social and economic development of these overseas territories to the advantage of their peoples and their development as a source of supplies for Western Europe and a contributor to the balance of payments. President Truman has clearly responded to this vision of the tremendous resources of the Middle East, Africa and the Far East being brought together, with European and American resources, for the purpose of making the whole world richer and safer. The significance of his proposal lies less in its novelty than in the evidence of American response to a challenge for economic and social planning on a bolder and more imaginative scale than the world has yet seen.

ISOTOPES IN BIOLOGY AND MEDICINE

A Symposium on the Use of Isotopes in Biology and Medicine

Contributors: Hans T. Clarke, Harold C. Urey, Glenn T. Seaborg, Paul C. Aebersold, Alfred O. Nier, Charles D. Coryell, Martin D. Kamen, Donald B. Melville, David B. Sprinson, Harland G. Wood, Konrad Bloch, David M. Greenberg, I. L. Chaikoff, Joseph G. Hamilton, Byron E. Hall, Saul Hertz, William F. Bale, James J. Nickson, Farrington Daniels. Pp. xiv+445. (Madison, Wis.: University of Wisconsin Press, 1948.) 5 dollars.

Advances in Biological and Medical Physics

Edited by John H. Lawrence and Joseph G. Hamilton. Vol. 1. Pp. xi+484. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 8.60 dollars.

Radioactive Indicators

Their Application in Biochemistry, Animal Physiology, and Pathology. By George Hevesy. Pp. xvi+556. (New York and London: Interscience Publishers, Inc., 1948.) 60*s*.

THESE three comprehensive volumes dealing with biological and medical applications of isotopes appear within a few months of each other, and mark a milestone in the subject. The rate of development in this field has been so rapid that the opportunity has scarcely arisen to take stock of progress. With their appearance a panoramic view of the literature is provided, with the help of which it becomes possible to assess what has been achieved and to speculate on future developments.

In the first place one is struck by some unusual, if not unique, facts about this new subject. There is, for example, the remarkable feature that it owes its development almost entirely to one man in Europe and to a large number of able investigators in America. This is reflected in the authorship of these books, which comprises G. Hevesy and thirty-one North American contributors. In the case of the radioactive isotopes, this feature may also be looked upon as a reflexion of the distribution of usable cyclotrons during the war years. Whatever truth there may be in this, it must be a cause of general satisfaction that the initial period of unequal opportunity is practically at an end and that isotopes are now within the reach of almost everyone.

It is also doubtful whether any other subject of present or past popularity can lay claim to such a wide audience. Listed among the contributors to these volumes are physicists, chemists, biochemists, physiologists, physicians and radiotherapists, each of considerable eminence in his own subject. In the case of the symposium held at Wisconsin, many of these were brought together in harmony around the same conference table, which is no ordinary occurrence in this specialized age.

Surveying some of the achievements, there is in the medical field the rapid estimation of thyroid efficiency, the location of extra-glandular thyroid tissue and the therapeutic destruction of malignant tissue whether in the gland or in functional secondaries, all by the use of radioactive iodine. This field is conservatively reviewed by I. L. Chaikoff, A. Taurog, S. Hertz and C. P. Leblond. Hevesy and P. F. Hahn set out the satisfying story of the conservation of iron in the body, particularly in relation to the life-span of the erythrocyte. The metabolism of compounds of nitrogen and carbon is reviewed by B. Vennesland and of proteins by D. B. Sprinson. Without detracting from the outstanding merit of their articles, the omission of D. Rittenberg's name from the list of contributors will not pass unnoticed. Much of his earlier work in association with R. Schoenheimer is dealt with in an article of excellent historical perspective by Hans Clarke. H. G. Wood writes on carbohydrate metabolism, whether studied indirectly with radiophosphorus or directly with carbon and deuterium. He makes no claim to completeness, and in this he has clearly been wise, since the prevailing enthusiasm for this field of work is such that in the interval since the article was written there has appeared little short of an avalanche of papers.

We owe to Hevesy more than to anyone the important conception of turnover-time, which shows signs of furnishing the basis for an entirely new point of view in biochemistry. His method of determining it, to take the case of phosphorus compounds as an illustration, is to maintain constant the specific isotopic activity of plasma phosphate and to compare it with the specific activity of the tissue compound at the end of an interval which is short in relation to the time required for complete renewal. This is the experimental basis of his statement (p. 279) that 20 per cent of the lecithin in rat liver is renewed every four hours. He fully recognizes that the value will be affected if the specific activity of intracellular inorganic phosphorus is not the same as that of plasma inorganic phosphate; in other words, the permeability of the cell membrane affects turnover time as determined by his method. However, it was

D. B. Zilversmit *et al.*[1] who first stated clearly in 1943 that the method could be seriously at fault if certain circumstances prevailed. For example, this will be the case if lecithin phosphorus happens to be derived by a rapid exchange from liver glycerophosphoric acid, which in turn happens to be synthesized only slowly from plasma phosphate. In such a case, over a short period of observation the isotope may scarcely reach the lecithin, whereas a considerable exchange of phosphate between lecithin and glycerophosphoric acid will have taken place. As Chaikoff and Zilversmit emphasize in their salutary article, it is essential to identify the immediate precursor, and Hevesy (p. 250) unequivocally supports their contention.

It will be helpful to many to find that this measure of agreement now exists between the experts. On the other hand, it was fortunate for the development of the subject that Hevesy should have adopted the less stringent conception of turnover time in his early work, since it is clearly better to have approximate figures to correct than none at all. This is certainly the choice, since the data required in order to apply the more precise method of the American workers are unobtainable for most intracellular substances or radicals. Fortunately this is not so in the case of plasma compounds, since the method of choice here, namely, to inject the labelled substance and observe its rate of disappearance from the plasma, makes no assumptions about the nature of the immediate precursor.

D. M. Greenberg writes on mineral elements, especially those of the skeleton and those possessing catalytic function, for example, iron, cobalt, manganese and zinc. Medical and therapeutic applications are left to E. C. Dougherty, J. H. Lawrence, J. G. Hamilton and B. E. Hall. There is a useful article by D. B. Melville on the preparation of compounds labelled with deuterium, carbon, nitrogen and sulphur.

A significant sign of the times is the inclusion of articles on health protection by H. M. Parker, W. F. Bale and J. J. Nickson. These are particularly timely in view of the increasing popularity of long-lived isotopes, particularly carbon-14 and iron-55, and of penetrating gamma-emitters, such as cobalt and zinc. Considerable space is devoted to the preparation and assay of isotopes, and the remaining names on the title-pages are mainly of contributors to these aspects. Much of the subject-matter here has appeared in review articles in physical and chemical journals, but its inclusion in volumes intended for the biologist is none the less welcome.

The popularity which isotopes have achieved in little more than a decade has been remarkable. It is safe to say that the next decade will see fresh discoveries in the field, but also, one hopes, the appearance of a more critical attitude to claims already made and recorded in these volumes. Following the spectacular demonstration of iodine uptake by the thyroid gland, the belief has grown that, provided an isotope emits gamma-radiation which is penetrating enough, it is only necessary to place a Geiger counter over the appropriate region of the body to derive the whole story of the isotopic uptake and excretion of a particular organ. The fallacy here is not based solely on the poor directional qualities of gamma-radiation but also on the fact that there are few sites in the body which compare with the thyroid in ability to concentrate elements selectively. Almost everywhere else, and with almost all other isotopes, there exists alike in the organ and in the surrounding tissues such a conglomeration of isotopic compounds, with vastly different exchange-rates, that the uptake and excretion by a region or organ as a whole have no useful significance.

Even where this is fully appreciated and the investigation is limited to an isolated compound, the biochemical difficulties of the isolation are, in many cases, only beginning to be appreciated. Tissue cells abound in macromolecules of high adsorptive capacity, with which are associated smaller diffusible molecules, frequently of high isotopic content. A few specialists in the field of surface chemistry have fully appreciated the tenacity of this adsorption, but many working with isotopes are apparently only now discovering it. In a recent investigation of the yeast cell[2] nearly all the phosphorus compounds isolated were found to be contaminated to some extent with other phosphorus compounds, especially metaphosphate, leading the authors to the conclusion that the results obtained from tracer experiments in general should be treated with great reserve until the fractions obtained have been reproduced by alternative methods of fractionation. Many, including the writer, will agree with this.

It is a pleasure to recommend all three volumes to serious workers in this field. For others, where a choice must be made, it is not possible to be categorical. Hevesy, in his monumental volume, has all the advantages of unity of authorship and maturity of outlook, but unavoidably he is not so reliable in some fields as the specialist contributor to the other volumes. Stable isotopes are excluded from his book, and some aspects of radioactive ones are not covered at all. Lawrence and Hamilton, on the other hand, have obtained the collaboration of specialists, including Hevesy, who are representative of the isotope field as a whole. Their articles dovetail much better than those in the symposium volume, which also shows some signs of hasty preparation.

A. S. McFarlane

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[1] Zilversmit, D. B., Entenman, C., and Fishler, M. C., *J. gen. Physiol.*, **26**, 325 (1943).

[2] Juni, E., Kamen, M. D., Reiner, J. M., and Spiegelman, S., *Arch. Biochem.*, **18**, 387 (1948).

HIGH-POLYMER PHYSICS

Mechanical Behavior of High Polymers

By Assist. Prof. Turner Alfrey, Jr. (High Polymers, Vol. 6.) Pp. xiv+581. (New York and London: Interscience Publishers, Inc., 1948.) 9.50 dollars.

THE unusually wide range of subjects covered by this work, the sixth volume in this series of monographs on high polymers, makes it difficult to give an adequate idea of its contents and method of approach in a short review. The book begins with what might be called an introduction to rheology—a concise treatment of the classical theory of elasticity, flow in Newtonian and non-Newtonian liquids, plasticity and thixotropy, and the simpler types of visco-elastic behaviour. This is followed by a discussion of the molecular mechanism of flow in amorphous linear polymers, and its formal analysis in terms of model systems, leading up to the development of the concept of a distribution of 'retardation times' or 'visco-elastic spectrum', from which the behaviour of a body under any type of stress variation may be derived. The third chapter deals with the statistical theory of the elasticity of cross-linked polymers (rubbers), and the statistical approach to the study of cross-linking and copolymerization—a fascinating field in which the correspondence between theory and experiment is refreshingly close—and associated problems.

In the remaining chapters the emphasis is on the observed properties of materials. Subjects dealt with are crystallization and its effect on mechanical properties of rubbers and fibres, the mechanical behaviour of wool and rayon, solution properties and plasticization of polymers. The final chapter deals with the question of tensile strength, both from the theoretical and experimental points of view.

Regarding the book as a whole, the treatment generally is sufficiently detailed and extensive for the reader to obtain a very fair grasp of the more important contributions to the subject, even without consulting the original literature. In many places sections of the original papers are quoted *in extenso*, which is extremely helpful for the reader who is actively engaged on research in a particular subject. On the other hand, this method has the drawback of breaking up the smooth development of the subject, making the presentation appear somewhat disjointed, with different parts of the same subject cropping up in various places. It is unfortunate that the section on optical properties could not have included a reference to the work of Kuhn and Grün (1942) on the statistical theory of the photo-elasticity of strained rubber.

The author is at his best in dealing with the general mathematical theory of visco-elastic phenomena, a subject to which he has made important contributions, some of which are set out in mathematical appendixes. The reviewer knows of no other book in which this subject is discussed in anything like the same detail, nor in such a masterly and lucid manner. Mathematics, however, is not physics, and the number of examples in which this kind of formal analysis has been successfully applied to real materials is still quite small. Moreover, there is the very serious difficulty (explicitly stated on p. 218) that the theory discussed is not applicable when the deformations encountered are large. Just as, in rubber elasticity, it has been found necessary to get right away from the classical (small-strain) theory and develop a theory in which large strains are included right at the start, so it may be necessary ultimately to develop a genuinely large-strain visco-elastic theory for the analysis of the non-equilibrium phenomena encountered in rubbers and plastics.

This is not a book for beginners; but for those who already have some knowledge and experience in high-polymer physics, it will be highly valued not only as an everyday guide but also, and perhaps primarily, as a source of inspiration for further research. L. R. G. TRELOAR

MECHANISM OF MAGNETIZATION

Paramagnetic Relaxation

By Prof. C. J. Gorter. Pp. vii+127. (New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1947.) 12*s*. net.

ALTHOUGH Langevin's theory of paramagnetism is known to every physics student, the study of the mechanism of the magnetization process is comparatively new; Waller's first calculations were published in 1932, and experimental investigations may be said to begin with Prof. C. J. Gorter's first paper in 1936. Since then it has been intensively studied under his leadership in several of the Dutch universities: but, up to the present, many of the results have been published only in the form of theses. This monograph, written in Holland during the 'starvation winter' of 1944–45, is the first book to be devoted to the subject.

The magnetization of a paramagnetic salt is an equilibrium between the forces exerted on the magnetic ions by the magnetic field, the random forces of thermal agitation, and the constraints due to interactions either among the magnetic ions themselves or between the ions and the surrounding crystal lattice. When this equilibrium is disturbed by a change of magnetic field, it can be re-established only by a flow of heat, which proceeds at a rate which can be described in terms of two characteristic relaxation-times. As the time for the establishment of thermal equilibrium among the magnetic ions, or spin relaxation-time, is generally appreciably shorter than that for equilibrium between the ions and the crystal lattice, and also has a different dependence on magnetic field, it is possible to separate the two effects experimentally.

After a brief review of the theory of paramagnetism, Prof. Gorter surveys the experimental methods used in relaxation work. Essentially, these are measurements of magnetic dispersion or absorption at different frequencies; but, as the relaxation times range from spin relaxation-times of 10^{-10} sec. to lattice relaxation-times which at low temperatures may exceed 0·1 sec., a great variety of techniques has been employed. The high-frequency circuit work is nowhere very elaborate—it must be remembered that the whole of the work described is based on 'pre-radar' radio technique—but some of the methods used are beautifully simple, notably the work of H. Volger. There follows a summary of the experimental results, and a discussion of their significance in the light of the theory of lattice and spin relaxation.

For many readers the greatest interest will lie in the values which emerge for the magnetic specific heats. When the spin relaxation-time is sufficiently short compared with the lattice relaxation-time, measurements at a suitable frequency give the magnetic susceptibility under adiabatic conditions, in which the magnetic dipoles, although in thermal equilibrium among themselves, are effectively isolated from the surrounding crystal lattice. From this measurement, combined with that of the ordinary isothermal susceptibility, the specific heat of the dipole system can be obtained by a simple thermodynamic transformation. In the few cases in which the comparison is possible, this elegant method gives specific heats which yield values for the magnetic energy-levels in good agreement with those obtained by other methods. The experimental results on relaxation-times, on the other hand, have not yet been fitted into a satisfactory theoretical framework. The dependence of the lattice relaxation-times on magnetic field is not consistent from one substance to another, while the experimental data do not yet suffice for a full analysis of its temperature dependence.

While its appeal is necessarily specialized, Prof. Gorter's book is an important contribution to the study of paramagnetism. It is beautifully produced and printed—an important point in a monograph containing so many numerical data. It has no index.

A. H. COOKE

Practical Five-Figure Mathematical Tables

By C. Attwood. Pp. v+74. (London: Macmillan and Co., Ltd., 1948.) 3*s*.

ALTHOUGH the contents of this volume do not differ essentially from those normally to be found in books of this kind, many innovations have been introduced in the arrangement and presentation, and the author has spared no pains to ensure that the comparatively limited space available is utilized to maximum advantage and efficiency. In addition to the ordinary tables of common logarithms, there is a supplementary table covering the range 1·000–2·099 at intervals of 0·01, and a similar feature appears in the trigonometrical sections, where entries are provided at 1′-intervals for cotangents and cosecants up to 18° and for secants and tangents in the range 72–90°.

Great emphasis has been laid, both in the preface and in a final explanatory section, on the use of proportional parts. The author explains, by means of well-chosen examples, the various methods that are available for avoiding or reducing the inaccuracies produced by mean proportional parts. The use of smaller ranges, where necessary, has already been mentioned and occurs constantly throughout the book. Other methods include backward interpolation, the use of inverse tables, and Bessel interpolation with second-order differences. Several illustrations compare and contrast the results of their application.

Other tables supplied include squares, cubes, square and cube roots, reciprocals, exponentials and hyperbolic logarithms; and the author has been wise enough to ensure that all differences to be subtracted are printed in red. He claims that more than 95 per cent of the 160,533 possible combinations of mean proportional parts produce no error or an error of one unit in the last figure, while less than 0·6 per cent produce an error in excess of three units. In a few cases, where the error is liable to exceed five units, italic type has been employed as a warning.

The book is beautifully printed and should prove a valuable asset in all elementary numerical work.

J. H. PEARCE

Technical Literature

Its Preparation and Presentation. By G. E. Williams. Pp. 117. (London: George Allen and Unwin, Ltd., 1948.) 7*s*. 6*d*. net.

MR. G. E. WILLIAMS' book is an expansion of his paper "The Presentation of Technical Literature", published in the *Journal of the Institution of Electrical Engineers* in 1944. To the extended sections of that paper Mr. Williams has now added chapters on the preparation of manuscripts, the art of sub-editing and on illustrations, and he also appends some notes on editing standards. In these respects his book differs from that of Prof. Kapp on "The Presentation of Technical Information", and although similar in scale and alike in their emphasis on the technical ideal that the treatment of a theme and the choice of words should be determined by their fitness for the purpose to be served, there are marked differences between these two books. Mr. Williams is concerned only with the writer, whereas Prof. Kapp deals with the lecturer also.

While the psychological approach is not overlooked, Mr. Williams emphasizes the factor of interest in his introduction—psychological principles bearing on the communication of knowledge are discussed separately in an appendix. Here Mr. Williams seems to be less successful than Prof. Kapp, though it is only fair to point out that these few pages are intended to serve no more than as an introduction to the subject, and that, unlike Prof. Kapp, Mr. Williams gives his readers clear guidance as to where further help may be sought. He includes a bibliography which, if not extensive, is adequate and discerning. The book is severely practical. It is lucid, well written and much to the point. For all the merits of Prof. Kapp's book, that of Mr. Williams will be preferred by many—and those not only the engineers and physicists primarily addressed—because, although slightly shorter, it is comprehensive and guides the student to the further sources where he may study, in greater detail, particular questions that arise in writing technical literature.

R. BRIGHTMAN

Notions fondamentales sur les vernis et peintures

Par Louis Kientz. Pp. xxi+234. (Paris: Gauthier-Villars, 1947.) 475 francs.

THE purpose of this book is "to inform the technician on the nature and properties of paints and varnishes". Such a limited aim the work fairly well achieves. Thus, there are chapters on resins, oils, pigments, paint testing and the like, where the information, if not novel in tenor or presentation, is of the kind likely to be useful to the paint technologist. However, some unfortunate statements have found their way into the text. Thus, to condemn fillers as solely useful for cheapening a paint, and as finding no place in a first-quality product (p. 70), is unnecessarily exclusive. It is a great pity that nothing better to illustrate the text could be found, assuming that illustrations are necessary, than a handful of ill-executed and uninformative line-drawings. The title is most misleading. It is true that a section will be found devoted to the theoretical concepts of physical chemistry, and throughout the text are scattered discussions on such matters as the mechanism of oil oxidation, structural formulæ of complex molecules, etc.; but these disquisitions are marred by a diffuseness and a lack of precision that render them more confusing than enlightening. Reference may be made, in illustration, to the inadequate treatment of viscosity and "rigidity" [*sic*] (p. 16), by which is meant anomalous viscosity, and of the classification of drying, semi- and non-drying oils (p. 45). Such imprecision, it must be admitted, is inescapable in a work almost purely descriptive; even the section on paint-testing is almost wholly uncritical. The absence of an index must seriously limit the value of this book as a work of reference.

Brachiopoda and Mollusca from the Productus Limestone of the Salt Range

By Dr. F. R. Cowper Reed. (Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 23, Memoir No. 2.) Pp. xii+596+65 plates. (Calcutta: Geological Survey of India, 1944, distributed 1948.) Rs. 63.2 or 96*s*.

ONLY a palæontologist who has lived through much of the development of his science could produce a volume such as this. The brachiopod and molluscan fauna of the Productus Limestone is described in detail with a wealth of references. Though only two new genera, *Blandfordina* (Limidæ) and *Palæolecanites* (Lecanitidæ), and one new sub-genus, *Haydenella* (*Productus*), are found necessary, there are no fewer than 177 new species and 114 new varieties. In this revision of the fauna certain of the conclusions reached by Waagen in an earlier monograph are rejected. In particular, the supposed

Visean affinities of a number of species from the Lower Productus Limestone, and the proposed palæontological zoning of the Middle and Upper Productus Limestone, are shown to be unsupported by evidence. The present author considers the Productus Limestone to be wholly Permian in age.

This work enables closer correlation to be made with Permian beds in other regions, and extremely close relations are apparent with faunas from West Australia, China and Tunisia. There are many anomalies, however. The rich faunas from Indo-China and Timor, for example, contain few identical species, and many of the gastropods are "extraordinarily like" those of the Pennsylvanian of America. Arctic species occur in all three divisions of the Productus Limestone. The author would prefer to regard many of the differences of fauna between Asiatic regions as indicating ecological (facies) variation rather than actual difference in age.

ALAN WOOD

Fishes and Shells of the Pacific World

By John T. Nichols and Paul Bartsch. (Pacific World Series.) Pp. v+201+16 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 12*s*. 6*d*. net.

THIS book provides an authoritative introduction to Pacific fishes and molluscs, and was written primarily to assist the thousands of service men spread over the Pacific Ocean during the latter half of the recent War. The descriptive section on the fishes is illustrated by a number of clear line drawings which are probably of even greater practical value than the photographs which illustrate the section on molluscs. The authors make no attempt to give a complete survey of these groups, but enough detail is provided for anyone to allocate a fish or mollusc to its family or genus. The book is, however, by no means confined to systematics; there are chapters on the origin and distribution of the fishes, on game fishes, and on the collection and preservation of fishes and molluscs.

In the section on molluscs there is a concise account of the chemical and physical factors in the sea, with a discussion of the part played by molluscs in the economy of the sea. There is a good short bibliography appended to the mollusc section of the book, but unfortunately there are no further references on the fishes.

Further popular books of this standard, covering other areas of the world, would be of great value, perhaps even in Great Britain, where many animal groups are still served by handbooks rapidly approaching their centenary.

Nuts

Their Production and Everyday Uses. By Dr. F. N. Howes. Pp. 264+16 plates. (London: Faber and Faber, Ltd., 1948.) 18*s*. net.

THIS is one of those useful books which present simply and shortly all but the more specialized aspects of one particular and comparatively limited subject—in this case the seeds and fruits that are popularly called 'nuts'. Apart from short introductory sections about the uses of nuts for food and their processing and storage, and an end section of cooking recipes, the book is in four parts, dealing respectively with tropical nuts, temperate nuts, nuts in Great Britain, and less familiar sorts. It is well produced and printed, and the illustrations as good as can be expected with such a subject.

As the author says, "most people relish nuts", especially children, and it is interesting to speculate how far this may come from the earliest days of human history when, it seems likely, nuts were one of the chief sources of food, especially in the warmer forest areas, where, indeed, they are still of much greater importance than elsewhere. Another interesting point is the way in which the book illustrates how various are the circumstances which may make or mar a vegetable commodity for purposes of modern commerce, a fact that may, in part, explain why the commercial plant-products of really first-rate importance are so few. Keeping qualities, the presence of unpalatable substances, the thickness of shells, the clinging of skins, the growth-form of the plant, the length of generation, and difficulties of harvesting or processing are but a few of the reasons why, among nuts at any rate, it seems that "the best is still to come".

Dr. Howes no doubt found it difficult to weigh fairly the claims to space of his different subjects, and on the whole he has kept a reasonable balance; but some disturbance of it might have been justified to allow consideration of so topical a matter as the African groundnut scheme. The statement, too, that this plant, which is assumed to be a native of America, has been cultivated in the Old World for "many centuries" is likely to raise some unnecessary hares. There might also be a more consistent insertion of the names of the families to which the various nuts mentioned belong. A detail of the book which is likely to appeal particularly to readers in Great Britain is the interesting account given of garden almond-trees. These often fruit surprisingly well, even on the rigorous north-east coast, where last year, for example, individual trees bore as much as thirty pounds of good fruit; Dr. Howes' reminder that the nuts from these fruits are usually perfectly palatable and wholesome is timely.

RONALD GOOD

Physics and the Surgeon

By H. S. Souttar. Pp. vii+60. (Oxford: Blackwell Scientific Publications, Ltd., 1948.) 7*s*. 6*d*.

THE mention of physics in any assembly of surgeons or physicians can be relied upon to arouse an immediate feeling of apprehension. An outstanding exception to this attitude is Mr. Souttar, who, besides being a surgeon of international standing, has acquired considerable repute as a physicist and mathematician. Unfortunately, the hopes raised by this combination of title and author are doomed to disappointment. The first half of the present book deals mainly with the mechanics and hydrostatics of human anatomy. There are fascinating accounts of the forces involved in muscle action, though the author is often so carried away in descriptive anatomy that the physics is left far behind.

The remainder of the book is devoted to atomic physics. In about thirty pages the reader is carried from the Rutherford atom, through the quantum theory, spectra, X-rays and radioactivity, taking in the cyclotron and isotopes in his stride. One is rather surprised to find that in a book dated 1948 the word 'neutron' appears only once, and the only instrument for detecting atomic particles mentioned is the spinthariscope. The many applications of atomic physics to surgery and medicine are not mentioned.

This book would need considerable expansion and revision in order to fulfil the promise of its title.

J. E. R.

THE UNIVERSITY COLLEGE OF THE WEST INDIES

MR. CREECH JONES, the Secretary of State for the Colonies, announced in January that a Royal Charter had been granted incorporating the University College of the West Indies, that the King had consented to accept the office of 'visitor', and that Princess Alice, Countess of Athlone, had been appointed the first Chancellor. The College does not possess power to grant degrees; its students will sit for the degree examinations of the University of London, until it has fully established its academic reputation and standards. The constitution has been so drafted that only minor changes will be needed when the College reaches the stage at which it feels justified in seeking university status.

The University College now enjoys full constitutional autonomy. The academic staff is strongly represented on the governing Council, and the Senate's control of academic policy is protected by the provisions of the Charter. The College has been admitted to the privilege of the "special relationship" with the University of London, which permits the teaching staff to propose changes adapting the curriculum to local opportunities and needs and to participate in the examining. This relationship guarantees the standard of the degrees, and at the same time gives the College a wide measure of freedom in linking teaching and examining to the research interests of the staff and to the special conditions of the West Indies. By this constructive co-operation with the University of London, the College will be enabled more quickly to work out the appropriate form which the local degrees should take when independent university status is achieved.

In the financial sphere, steps are similarly being taken to give maximum freedom to the College. Without endowments, it is at present dependent for its capital needs on grants from the Imperial Government, and for its recurrent income on contributions from the seven local governments. Devices for avoiding the possible dangers of this dependence, which have proved effective in the United Kingdom, have been adopted. The capital voted for the College under the Colonial Development and Welfare Act may amount to £1½ million, and is administered on the advice of a Colonial University Grants Committee predominantly academic in its composition. The local contributions are given as block grants, not earmarked in details, and as soon as the recurrent needs of the College can be more accurately forecast, they are likely to be given for three- or five-year periods at a time on the model of the quinquennial grant system for the universities of Great Britain.

The general plans for the College were sketched in the report of the Committee under Sir James Irvine which made an extensive tour of the Caribbean in 1944. The Committee recommended that the College should be unitary, residential and located in Jamaica. Although some of the seven territories must have been disappointed that they were not to be hosts to the College, there has been the fullest support from all, and the College is emerging as one of the first 'federal' institutions in the British West Indies. Student admissions are made not on a territorial quota basis but by competition; scholarships and the payment by the College of return passages to Jamaica ensure that candidates are not at a disadvantage through poverty or residence in an island remote from Jamaica. Jamaica has responded generously to its obligations as host to this West Indian institution by presenting a superb site of nearly 700 acres lying between the Blue Mountains and Long Mountain, six miles from Kingston, and by undertaking to meet a substantial part of the cost of an entirely new hospital which is being built on the site as the teaching hospital for the College medical school.

The inter-territoriality of the College has been emphasized by the work of its Department of Extra-Mural Studies, which began shortly before the internal teaching. Six of the seven full-time resident tutors have already taken up their duties in the territories to which they have been assigned; training courses for part-time tutors have been conducted by a specialist lent by the Oxford Extra-Mural Delegacy; and for the twenty-six classes in Jamaica in the autumn term of 1948 there were 1,200 students enrolled.

On the College site in Jamaica there is an extensive hutted camp, some parts of which have been adapted into temporary laboratories, halls of residence, library, students' union and staff accommodation. Designs for the permanent College and Hospital buildings by the architects, Messrs. Norman and Dawbarn, are well advanced, and it is expected that the contractors will begin work on the site within a few months. The availability of the temporary huts has made it possible for teaching to begin on a small scale; thirty-two students, including nine women, were admitted to the Faculty of Medicine in October 1948. A similar number will be admitted for the session 1949–50, together with about twenty-five students in the Faculty of Science. The Faculty of Arts will open in 1950 or 1951, depending on the progress of the permanent buildings.

The progressive stages in the starting of teaching has dictated the programme of staff appointments. The principal, Dr. T. W. J. Taylor, the director of extra-mural studies, Mr. Philip Sherlock, and the registrar, Mr. H. W. Springer, were appointed in 1946–47, the librarian, Mr. Harold Holdsworth, formerly of the Universities of Leeds and Cape Town, in 1948. The professor of botany, Dr. G. F. Asprey (formerly of the University of Aberdeen), the professor of zoology, Dr. Norman Millott (formerly of the University of Manchester), the professor of chemistry, Mr. C. H. Hassall (formerly of the University of Otago, New Zealand, and a research student at Cambridge), and the senior lecturer in physics, Mr. F. H. Bowen, took up their appointments early in 1948. Dr. W. F. Harper (London Hospital Medical College, University of London) has recently been appointed to the chair of anatomy, and Dr. I. F. Mackay (University of Durham) to the chair of physiology. Junior appointments have been made from the United Kingdom, Canada, South Africa and New Zealand. Of the twenty members of staff already appointed, eight are West Indians.

The importance attached by the College to the development of research is illustrated by the fact that it has already established one of its institutes, that for economic and social research, with Dr. H. D. Huggins as director. Undergraduate teaching in the social sciences may have to wait until the work of the Institute has begun to systematize the relevant data, to define some of the trends and problems of economic and social developments in the Caribbean, and to prepare the way for publications and other teaching material.

The University College of the West Indies faces many problems, such as its need for further funds and endowments and the task of building up its library resources at a time of famine in books; but the speed and efficiency with which it has developed in its first two years augur well for its further progress.

BUILDING RESEARCH IN GREAT BRITAIN

THE work carried out at the Building Research Station under the direction of the Building Research Board is well known to all those interested in the design and construction of civil engineering works of every kind and size, and the appearance of the first report of the Board* after the interruption caused by the War is very welcome.

The report covers the period 1940–45, and is divided into two parts, the first of which deals with the normal programme of research in progress in 1945. The second gives an account of the work carried out at the Building Research Station during the War, but contains much information capable of more general application. Finally, there is a classified list of technical publications by the Board and by members of the staff of the Station, which provides a useful guide to current literature. The field covered by the report is very wide, and the space devoted to each aspect of research is necessarily brief; but enough information is given to make clear the method of research and the results obtained.

The first section of the main body of the report deals with investigations into structural materials. The Station has collaborated in a technical survey of the brick-making industry, the testing programme for which was completed in 1945. Work on cement and concrete has dealt with the suitability of different types of limestone aggregates for roads, and with various light-weight concretes. Methods of steam curing have also been studied, and a programme of tests has been carried out at a factory making precast concrete products, to examine the degree of control of quality attainable. Methods which have been developed for determining the specific surface of cements by measurement of air permeability or by nitrogen absorption are likely to be applicable to many other fine powders, and have already been used for some industrial materials.

Perhaps the most generally interesting part of the Station's work is that dealing with the design of domestic buildings. Here the investigation falls into two parts, the first dealing with structural tests on non-traditional methods of construction, and the second with heat insulation, lighting, plumbing and ventilation. The experimental work was carried out on complete houses built for the purpose on land adjacent to the Station. These were then let to tenants whose daily experiences will provide a check on the conclusions reached experimentally. This work is to be continued and extended. Before leaving the subject of house construction, mention must be made of the committees set up by the Ministry of Works to study various aspects of post-war building. The Station was responsible for five of these committees, and provided assistance to others.

Another major investigation is that which started in conjunction with the Ministry of War Transport into the behaviour under load of composite bridge deck systems. The approach to this problem is of interest as indicating the systematic methods adopted by the Station when dealing with complex practical problems. The mathematical analysis is complicated and lengthy, and a series of full-scale tests to cover the whole field is obviously impracticable. The analysis will therefore be accompanied by a number of tests on small models, and the results from these will be compared with those obtained from a few larger models and from actual bridges, thus indicating whether any special conditions of restraint which occur in actual structures have been left out of consideration in the laboratory tests.

Other tests made on existing bridges to determine their suitability for the heavy traffic of war-time showed that many old bridges could safely carry a load of two or three times their 'safe load' as estimated by the usual methods. It was also found that in no case did the dynamic stress caused by a travelling load exceed by more than 30 per cent that produced by the same load at rest.

In connexion with these and other tests, much work has been done on the development and use of the acoustic strain-gauge and the wire-resistance strain-gauge. The acoustic gauge has been found to be particularly valuable both for field and laboratory work, and a method of measuring dynamic strains with it has been worked out. The description of the mobile instrument laboratory is of interest.

Work on soil mechanics has been directed mainly towards the general problem of house foundations. In particular, the cracking and settlement of dwelling houses on clay has been studied, and types of foundation design have been evolved which should prevent this trouble. A point of interest is the discovery that fast-growing trees, such as poplars and elms, may cause serious cracking at distances of as much as 50 ft., owing to the withdrawal of water by their roots.

Studies have also been made of the soil conditions on the sites of several large new civil engineering works. One of the most interesting is the comprehensive investigation carried out in connexion with the proposed Flood Protection Scheme in the Fenland.

The war-time work of the Station ranged from the examination of possible substitutes for scarce materials, such as the use of synthetic bauxite in the manufacture of aluminous cement, to model tests of the effect on structures of explosions in earth, air and water. One of the most spectacular was the destruction of the 1/20-scale model of the Mohne Dam. The success of the air attack made in 1943 upon the actual dam is well known.

A war-time development which will be of permanent value was the establishment of a sound basis for the design of reinforced concrete railway-sleepers. Measurements were made of the load transmitted to the sleeper during the passage of the train, using a robust and compact weighing-device, which, after removal of a chair, could be placed between the rail and sleeper without disturbing the foundation of the tracks. The distribution of pressure under the sleeper was measured by placing between it and the ballast a 'ball sandwich', composed of two steel plates between which were 150 or more hardened steel balls.

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* Department of Scientific and Industrial Research. Report of the Building Research Board, with a Report of the Director of Building Research for the Years 1940–1945. Pp. viii+112. (London: H.M. Stationery Office, 1948.) 3s. 6d. net.

By measuring the indentations made by these, the load distribution could be determined.

The risk of fire is present both in peace and war, and has been studied by the Station from several points of view. The effect of heat on the strength of concrete and other structural materials has been examined. Tests have been developed to evaluate the degree to which different wall-coverings contribute to or retard the rapid spread of fire. The principles of lay-out to prevent the spread of fire by radiation between buildings have been worked out.

It has only been possible to refer to the more important items discussed in the report; but it will be seen that the range covered includes something of interest to anyone concerned with civil engineering construction. It is satisfactory to learn from the introductory report of the Board that the importance of the Station's work has been recognized by the recruitment of additional staff and the provision of further facilities for research.

MOON ECHOES AND PENETRATION OF THE IONOSPHERE

By F. J. KERR, C. A. SHAIN
AND
C. S. HIGGINS

Division of Radiophysics, Council for Scientific and Industrial Research, Australia

NORMAL ionospheric sounding technique can provide information on only the lower portion of the *F*-region, since waves capable of reaching beyond the level of maximum ionization are not returned to earth by any processes occurring within the ionosphere itself.

The reception of solar and cosmic radio noise at the earth's surface demonstrates that radio energy of sufficiently high frequency can penetrate the ionosphere, but unexpected ionospheric effects are sometimes found in records of 60 Mc./s. solar noise near sunrise. For a study of transmission right through the ionosphere, a signal from a controlled source is to be preferred to the highly variable emissions from the sun. It was thought that signals reflected from the moon might be used in this way for investigation of the ionosphere, and a series of exploratory tests was therefore undertaken.

Moon echoes were first obtained by the U.S. Army Signal Corps[1] and by Bay[2] early in 1946, in the metre wave-length region. The American observers reported large amplitude variations, which may have been due to ionospheric effects. For a specific study of the ionosphere it is desirable to work at lower frequencies, and it has been possible to use facilities already available in Australia for preliminary tests at these frequencies.

The results obtained to date may be summarized briefly as follow:

(1) Echoes from the moon have been obtained on thirteen out of fifteen attempts.

(2) The amplitude of the echoes was sometimes of the order expected on theoretical grounds, but more commonly it was considerably less.

(3) As the moon rose, echoes could not be obtained until the moon's angle of elevation was higher than was expected from calculations based on vertical-incidence ionospheric soundings.

(4) Analysis of 20 Mc./s. solar noise also shows ionospheric effects, with the significant difference that solar noise energy has been received at lower elevations of the sun than expected.

Experimental Arrangements

On several days each month, the moon passes through aerial beams used by the high-frequency broadcasting station Radio Australia for regular transmissions to the United States and Canada. This station is located in Shepparton, Victoria. With the co-operation of the Postmaster-General's Department, arrangements have been made for the use of a transmitter at this station when it is not required for broadcasting. The transmitter is pulsed by land-line from the Radiophysics Laboratory receiving station at Hornsby, New South Wales, 380 miles away. The electrical characteristics of the system used in the preliminary tests are summarized below.

Transmitter: *VLC*9, 17·84 Mc./s., 50 kW. output, or *VLB*5, 21·54 Mc./s., 70 kW. output.

Receiver: R.C.A. type *AR*88 communications receiver, with the band-width adjusted to 70 c./s. The stability with regulated supplies was such that slight retuning was necessary every 10–15 min.

Transmitting aerial: 16-element broadside array, with maximum of beam at 63° azimuth, 9° elevation, and first minimum in vertical plane at 23½°. Gain over an isotropic radiator, 22 db.

Receiving aerial: Rhombic aerial system, directed towards the region of the sky illuminated by the transmitting aerial. Beam steerable over a limited sector in the horizontal plane. Calculated gain over an isotropic radiator is 17 db. at 17·84 Mc./s.

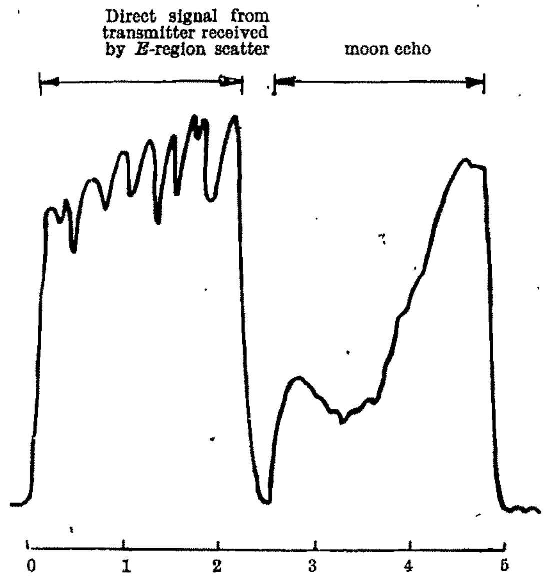
Display: (*a*) Long-persistence cathode-ray tube, and photographic recording. (*b*) Loudspeaker, using the beat-frequency oscillator of the receiver. The aural method was the more sensitive for detection of weak echoes.

Keying procedure: The most frequently used keying signals were: (*a*) A group of three ¼-sec. pulses (for identification of weak echoes). (*b*) A single pulse 2·2 sec. long (for studying short-period amplitude variations of the echo, which began to appear 2·6 sec. after the start of the transmitted pulse). The pulse repetition period was 6 sec.

Owing to the use of fixed aerials, observations are possible only when the moon is within the beam of the aerials, ionospheric conditions are suitable, and 'Radio Australia' is not required for broadcasting. The moon passes through the aerial beam on several successive days for two periods each month, at times related to sidereal time and hence varying with respect to solar time. The transmitters are available only during 0230–0530, 0930–1230 Eastern Australian Standard Time. In the latter period, the critical frequency of the F_2-region is usually too high for penetration to be possible. Hence the working time of the system is restricted to days when the moon is in the required part of the sky between 0230 and 0530, that is, to about twenty days in a year.

Echo Characteristics

Observations have been made in the 0230–0530 period on thirteen days, moon echoes being received on twelve of these for an average time of forty minutes. The less suitable 0930–1230 period was used only on two magnetically disturbed days, on one of which echoes were received.



Tracing of photograph showing typical amplitude variation of moon echo during a single 2·2-second pulse. The small fluctuations on the echo trace represent cosmic noise (I.F. band-width = 70 c./s., video band-width = 6 c./s.)

The echoes have shown considerable amplitude variation. First, their strength was found to be much less on some nights than on others. The maximum amplitudes for the various runs, after correction for aerial performance at the angles concerned, showed a variation of more than 20 db., considerably greater than the experimental uncertainty.

Secondly, within a single test the mean amplitude taken over several minutes varied widely. This type of variation showed periods of 5–20 min. For example, on one occasion the echoes were strong enough to overload the receiver during the signal peaks for about 10 min., and then the intensity fell to a barely audible level for a time. Observations normally began shortly after moonrise, echoes being first received when the moon had passed out of the '*F*-region shadow'. The first appearance of the echoes was usually fairly sudden. From the accepted picture of the ionosphere, it might be thought that once echoes had been detected the amplitude would then depend mainly on the polar diagram of the aerial, as the moon elevation increased. In some of the tests the mean amplitude of the echoes varied in this way, but in most cases large amplitude variations of the type mentioned above were superimposed on the variation due to the aerial. On some occasions the echoes were lost completely after a short time, although the moon was still in the aerial beam; on others they faded in and out several times during the period of observation. A striking example of this occurred on March 14 during an ionospheric disturbance. On this occasion moon echoes were received for 23 min., and then lost for 30 min. before being detected again just as the moon was leaving the aerial beam.

Thirdly, considerable short-period fading has been observed. Using the three-pulse system (quarter-second pulses a half-second apart), it was quite common to receive only one or two echoes out of the group of three. An example of a record obtained with a 2·2-sec. pulse and showing a short-period fading is given in the accompanying figure. This fading with periods of less than a second is not unlike that observed in signals reflected from the ionosphere, and so may be mainly ionospheric in origin.

Absolute Amplitude of Echoes

The echo cross-section of a large body is equal to the product of the projected area, the mean reflexion coefficient of the surface, and the directivity of the reflected energy in the direction of the transmitter. The reflexion coefficient depends on the dielectric constant, and the directivity on the shape and roughness of the surface. The strength of the echo from the moon was calculated from the standard radar equation, with reasonable assumptions concerning the reflecting properties of the moon.

The noise background at these frequencies consists mainly of cosmic noise. For a fixed low-angle aerial system, the cosmic noise-level varies with sidereal time and with ionospheric conditions. The noise temperatures at the times of the various tests were of the order of 10,000–20,000° K.

The calculated echo-strength was 30 db. above 15,000° cosmic noise, taking the moon at the centre of the aerial beam and neglecting ionospheric effects. In four of the thirteen tests in which echoes were received the maximum observed echo intensity, with suitable allowance from the theoretical aerial diagram, was within ± 5 db. of the calculated level. This is within the uncertainty of measurements with the equipment used in the exploratory work. In the other nine tests the maximum echo-strength was less by amounts of up to 20 db. On no occasion has the echo intensity exceeded the calculated level by more than the experimental uncertainty.

It cannot yet be said whether the reductions in intensity and the long-period variations are due to ionospheric, lunar or inter-planetary causes. Grieg, Metzger and Waer[3] seek to account for the amplitude variations in the American moon-echo experiments in terms of the interference fading produced by echoes from two or three 'bounce points' on the moon. Such a mechanism could produce short-period fading, but it is scarcely likely that day-to-day variations could arise in this way. If the echo intensity from the moon were predominantly due to reflexion from a few areas with favourable aspect, the echo would at times be expected to rise well above the calculated value for a rough sphere. No such high intensities have been found. An ionospheric origin for the slow variations seems more likely. Simultaneous reception of moon echoes at two points on the earth would provide evidence about the source of the variations.

Doppler Shift

The frequency of the received echoes was about 50 c./s. higher than that of the transmitted signal, the difference being clearly audible in the loudspeaker as a change in the note produced by the beat-frequency oscillator of the receiver. When the echo was sufficiently strong, it was possible to beat the two frequencies together. The frequency shift arises mainly from the Doppler effect of the earth's rotation, with smaller contributions from the moon's radial velocity, phase changes in the ionosphere, and variations in the effective centre of reflexion on the moon. An analysis of the effects of the various factors suggests that precision determinations of the shift and its time variations could be used to yield new information on the *F*-region. New determinations of certain astronomical and geodetic quantities could

Table 1. *F*-Region penetration

Conditions for the transmitted ray at the times of first detection of moon echoes, compared with the theoretical limiting angles for reflexion from the *F*-region back to ground. Following convention, angles of elevation and emission are measured from the horizontal, and angle of incidence from the normal to the *F*-region

Date (1947)	Frequency (Mc./s.)	Time of first detection of echoes (150° E. time)	Angle of elevation of moon	Theoretical minimum angle of emission for penetration	Observed maximum angle of incidence on F_2 for penetration	Theoretical maximum angle of incidence on F_2 for penetration
Nov. 7	17·84	0355	16·7°	12·2°	66·6°	69·8°
8	21·54	0348	10·7	6·2	70·4	72·3
9	21·54	0407	9·2	0	71·1	73·6
10	17·84	0502	14·9	0	67·3	74·5
Dec. 6	21·54	0234	13·5	8·2	69·3	72·2
7	21·54	0238	9·3	8·0	71·5	72·1

also be obtained, but only under very favourable ionospheric conditions.

Penetration Angles

A study has been made of the conditions under which the ionosphere is first penetrated, as the moon rises. The lowest angle at which echoes can be received is in the nature of a critical angle for the sensitivity employed. These minimum angles have been compared with the critical angles for the reflexion of waves from the *F*-region as calculated from the theoretical results of Appleton and Beynon[4].

Owing to the large distance between transmitter and receiver, the two directions of transmission through the ionosphere must be considered separately. *F*-region characteristics for the two estimated penetration points were derived from the vertical incidence data recorded every 10 min. at Canberra and Brisbane. From these were calculated the theoretical minimum angle of emission from the ground and maximum angle of incidence on the *F*-region for penetration. The theoretical minimum angle of emission was then compared with the elevation of the moon at the first detection of echoes, and the theoretical maximum angle of incidence compared with the angle of incidence on the *F*-region of a straight line from transmitter or receiver in the direction of the moon.

Under the conditions of the experiment, the elevation of the moon was about 5° less at Shepparton than at Hornsby. It is to be expected, therefore, that the elevation of the moon at Shepparton would determine the time at which echoes were first detected. As against this, a somewhat lower critical frequency was generally appropriate to transmission than to reception, in consequence of Shepparton's higher latitude. The difference in angles of elevation was found to be the more important effect, so that the limiting angles for echo-detection may be taken as those for the transmitted rays.

Table 1 presents the information on penetration conditions from the transmitter for the first six tests in which moon echoes were detected. It can be seen that echoes were not detected until the moon had risen well above the theoretical minimum angle of emission for penetration. Angle of incidence on the F_2-region is a more significant quantity than angle of emission. The table shows that the average difference between theoretical and observed limiting angles of incidence for penetration is 3°. This comparison refers to the angle of incidence on the F_2-region of a straight line from the transmitter to the moon. The angle of incidence of the penetrating ray will in general be less than this, as the ray path below the ionosphere will be closer to the normal than the ray path above, owing to the deviation which occurs in passing through a curved ionosphere. Under the conditions of the experiment, this deviation amounts to about 1–2° on current ionosphere theory. The effect is in such a direction as to increase the difference between the angle of incidence at which moon echoes might have been expected to appear and the angle at which they were first detected. Although the onset of the echoes was usually fairly abrupt, the maximum angle of incidence for penetration may not be as 'critical' as that for reflexion, and would possibly be reduced by the use of a more sensitive system.

Solar Noise

Information on penetration of the ionosphere is also obtainable from a study of solar noise. In the 20-Mc./s. region no general level of solar noise can be seen, but bursts often stand out from the cosmic noise background. Despite the sporadic nature of these bursts and their wide range of amplitude, useful results on penetration of the ionosphere can be obtained from the records. In contrast with the moon-echo results, it is not uncommon to receive solar noise bursts with the sun below the theoretical minimum elevation for penetration. Some examples are shown in Table 2. (The only theoretical results available on limiting angles for penetration are for the case of penetration from below.)

In comparing the evidence on ionospheric penetration obtained from moon echoes and from solar noise, two points must be remembered. First, in the echo experiments the limiting conditions were those for penetration of the ionosphere from below, whereas for solar noise, penetration was from above. The second difference is that the amplitude range for detectable solar noise bursts is greater than that for detectable moon echoes. Hence, if the cut-off at the *F*-region shadow were not sharp, high-intensity solar noise bursts could be seen at lower elevations than is possible for moon echoes. Present evidence sug-

Table 2. Examples of reception of solar noise bursts with the sun below the theoretical *F*-region shadow angle, as calculated from vertical incidence data

Date	Frequency (Mc./s.)	Time of reception of burst from sun (150° E. time)	Angle of elevation of sun	Theoretical minimum elevation for reception of penetrating rays	Observed angle between straight line from sun to receiver and normal to lower side of F_2	Theoretical maximum angle between penetrating ray and normal to lower side of F_2
July 10, 1947	18·3	1039	30·8°	37·2°	55·9°	50·2°
July 16, 1947	18·3	0938	24·9	31·5	61·0	55·3
April 16, 1948	18·3	1526	23·6	37·4	62·2	50·2

gests, however, that the cut-off is fairly abrupt, leading to the conclusion that transmission through the ionosphere in the two directions, from below and from above, appears to be different. Such lack of reciprocity could arise from the effect of the earth's magnetic field.

The work described in this paper is part of the research programme of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia.

[1] Mofenson, J., *Electronics*, 19 (4), 92 (April, 1946).

[2] Bay, Z., *Hungaria Physica Acta*, 1, 1 (1946).

[3] Grieg, D. D., Metzger, S., and Waer, R., *Proc. Inst. Rad. Eng.*, 36, 652 (1948).

[4] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, 52, 518 (1940); 59, 58 (1947).

OBITUARIES

Dr. F. H. A. Marshall, C.B.E., F.R.S.

Born at High Wycombe on July 11, 1878, Francis Hugh Adam Marshall died suddenly after an operation in a Cambridge nursing home on February 5. He was the younger son of Thomas Marshall, and was educated at St. Mark's School, Windsor, and privately. After a short time at University College, London, he went up to Christ's College, Cambridge, in 1896 and took the Natural Sciences Tripos. Inspired by the work of Walter Heape in Cambridge on sex physiology, he then accepted an invitation to work in Edinburgh with Prof. Cossar Ewart, who at that time was conducting his well-known experiments on telegony in farm animals at Penicuik. Here he started his research career and worked in conjunction also with the distinguished group of research physiologists centred around Sir Edward Sharpey Shafer. During this time he published many valuable papers on the œstrous cycle in the sheep (1903), the ferret (1904) and the dog (1905); but perhaps one of the most important was that on "The Ovary as an Organ of Internal Secretion", for it led to large developments in this field later. The University of Edinburgh honoured him with a D.Sc. and later with an LL.D. degree, and he was elected a fellow of the Royal Society of Edinburgh.

In 1908 Marshall returned to Cambridge, where he became lecturer in agricultural physiology in the newly formed School of Agriculture. He was also elected a fellow of Christ's College and lectured to medical students in the Department of Physiology on reproduction. It was during these years that he gathered the materials for and wrote his classical book on "The Physiology of Reproduction", which was first printed in 1910, a second edition appearing in 1922. This book appeared at an opportune time, for during that period research work was expanding rapidly in the United States and elsewhere, and the book, giving complete references to the literature on the subject, formed a background for the spectacular advances made later on the internal secretions of the reproductive organs, a subject to which much of Marshall's earlier work was devoted. At the time of his death he was busy with proofs of the third edition of this book, chapters for which had been contributed by many of his former pupils and associates whom he had inspired by his passionate devotion to his subject.

In the period of some thirty-five years during which he was lecturer, and afterwards reader, in agricultural physiology at Cambridge, he also laid the foundation for this subject as a basis for training in animal husbandry, and his book on the "Physiology of Farm Animals" is widely used and has run through several editions. In conjunction with the late Prof. T. B. Wood, the first director, he helped to develop the Institute of Animal Nutrition at the School of Agriculture, Cambridge, and became director himself for a short time after Wood's death. For his work for agricultural science he was made a C.B.E.

Marshall's literary talents were well developed and he wrote with a clarity and ease of style which held the attention of his readers. These powers he put to good use not only in his books but also as editor of the *Journal of Agricultural Science* and as a founder member of the editorial boards of the *British Journal of Experimental Biology* and the *Journal of Endocrinology*.

In 1920 he was elected a fellow of the Royal Society and served on the Council from 1933 until 1935. In the following year he delivered the Croonian Lecture on "Sexual Periodicity and the Causes which Determine it", in which he stressed the exteroceptive factors, especially of light, a subject on which he did much experimental work in his later years. He was awarded a Royal Medal in 1940.

At Cambridge Marshall played his part, too, in academic affairs, becoming tutor, dean and finally, in 1940, vice-master of Christ's College. He was a proctor during 1911–12 and afterwards served on the Council of the Senate. His kindly and gentle manner endeared him to his students and to the many aspiring research workers who came to seek his advice from far and wide. John Hammond

Prof. L. Farkas

The death of Ladislas Farkas, at the age of forty-four, removes from our midst a relatively young physical chemist of singular charm and undoubted ability.

Ladislas Farkas was the younger son of a Hungarian pharmacist living at Dunaszerdahely, and, like his elder brother, revealed a particular aptitude for physical chemistry. He attended the Technische Hochschule in Berlin, and then worked with Prof. Fritz Haber at the Kaiser Wilhelm Institut in Berlin-Dahlem at the period when the possible participation of atoms and radicals in chemical reactions had been recognized and demanded intensive investigation. His work here was so effective that he was promoted to 'assistant'. As the Nazi regime in Germany became more definitive, he found his position becoming more difficult, and he emigrated to work in the Department of Colloid Science at the University of Cambridge.

Deuterium, at that time, was scarcely obtainable in Britain, and its obvious utility, on account of the mass and zero point energy differences, in throwing light on the detailed mechanism of homogeneous, heterogeneous and catalytic reactions, suggested a promising field for inquiry. Farkas prepared deuterium compounds by the orthodox electrolytic and diffusion processes, and in addition elaborated a number of ingenious partition and chemical methods for its separation. The results of the investigation of a number of chemical and catalytic reactions, in which hydrogen and hydrogen-containing compounds were replaced by deuterium, were presented in a series of papers. His experimental work was characterized by elegance in design and execution, while his theoretical insight, already appreciated by Haber, was confirmed by his British co-workers.

Before the Second World War, when the Hebrew University of Jerusalem was undergoing extension, Farkas, at the request of Dr. Ch. Weizmann, joined the staff there and was appointed professor of physical chemistry in 1936, a post which he held at his death. During the last ten years he was particularly active in training young chemists in Israel. Early in 1942, the Palestine War Supply Board set up a scientific advisory committee to co-operate with the Middle East Supply Centre in Cairo, and Farkas became its scientific secretary. He developed methods for the local production of many important chemicals such as ethyl chloride, ethylene bromide and vitamin D.

He took an active part in the exploitation of the Dead Sea minerals, particularly the recovery and utilization of bromine.

At the end of December Farkas left Jerusalem for the United States to purchase scientific equipment, and on this journey he was the victim of an aeroplane crash in the vicinity of Rome. ERIC K. RIDEAL

WE regret to announce the following deaths:

Dr. Tenney L. Davis, emeritus professor of organic chemistry in the Massachusetts Institute of Technology, and editor-in-chief of *Chymia*, an annual publication devoted to historical chemistry, on January 25, aged fifty-nine.

Prof. T. S. Patterson, Gardiner professor of organic chemistry in the University of Glasgow, on February 14, aged seventy-six.

NEWS and VIEWS

Department of Scientific and Industrial Research: Sir Edward Appleton, G.B.E., K.C.B., F.R.S.

THE appointment of Sir Edward Appleton to be principal and vice-chancellor of the University of Edinburgh was announced in November last, and he will be taking up his new duties there in May. Sir Edward became secretary of the Department of Scientific and Industrial Research in February 1939, after a brilliant university career, during which he conducted his classical researches on the transmission of radio waves which led to the award of the Nobel Prize for Physics in 1947 (see *Nature*, November 22, 1947, p. 703). During the ten years he has been with the Department of Scientific and Industrial Research, Sir Edward has devoted all his energy to its interests and purposes. These are broadly: first, to seek scientific truth by carrying out research in the Department's establishments and by encouraging programmes of research in other appropriate places; and secondly, to foster the application of scientific knowledge for the benefit of the community. This period of service has included the arduous war years during which the duties and responsibilities of the head of the Department were particularly onerous and of vital importance to the nation. As an administrator, Sir Edward has come to be respected by all the staff who worked under him; as the Civil servant who represented the Government in all branches of science, except medicine, agriculture and fisheries, he has commanded the attention and appreciation of the whole of Britain. His wisdom, shrewdness and gentle, but persuasive, drive have made him much sought after as chairman of national committees of all types, whether these were concerned with scientific or technical matters or with the practical details of staffs and their organisation. Throughout his decade of Government service, Sir Edward has succeeded in maintaining a close and active interest in the field of radio science which he has made his own and for which he has an international reputation. There is little doubt that, while in his new position he will naturally be mainly concerned with university administration, he will find opportunities to continue his favourite line of research work.

Sir Ben Lockspeiser

SIR BEN LOCKSPEISER, who succeeds Sir Edward Appleton as secretary of the Department of Scientific and Industrial Research, was born in 1891. He was educated at the Grocers' School, London, and Sidney Sussex College, Cambridge. He served in the First World War, taking part in the Gallipoli Campaign. Invalided home, he worked under Prof. A. V. Hill on problems relating to fuses. His association with aeronautics started in 1920, when he went to the Royal Aircraft Establishment, Farnborough. He was at first engaged in research on crystal structures with Dr. A. A. Griffith; later he worked on aerodynamics and instrument design. He made valuable contributions to the theory of aircraft flutter and to the development of a chemical method of de-icing. He was placed in charge of the Air Defence Section at the Royal Aircraft Establishment in 1937, and it was perhaps in this that his best work, most of it secret, was done. He was transferred to the Ministry of Aircraft Production to take charge of armament research, being made assistant director in 1939 and deputy director in 1941; he became director of scientific research in succession to Dr. D. R. Pye in 1943, and director general in 1945. When the Ministry of Supply took over the responsibilities of the Ministry of Aircraft Production for aircraft, the need for a man of science to co-ordinate the scientific investigations of the whole Ministry was apparent, and Sir Ben was appointed as chief scientist to take over this work. Throughout his career Sir Ben has taken a strong interest in the status of scientific workers in the Civil Service; much of the improvement in conditions of service that has been achieved is due to his untiring efforts.

Physiology at University College, London: Prof. C. Lovatt Evans, F.R.S.

PROF. CHARLES LOVATT EVANS is retiring at the end of the present session from the Jodrell chair of physiology at University College, London, which he has occupied since 1926. He was originally a student and is now an honorary LL.D. of the University of Birmingham. He then went to University College as Sharpey Scholar in Starling's laboratory and qualified in medicine at University College Hospital. As a fellow of the College, as professor and as dean of the Faculty of Medical Sciences, he has spent a large part of his active life in the place. As a member of the Medical Research Council, of the council of the Royal Society (vice-president), of the council of the Royal Veterinary College and of many other bodies, as an experienced examiner at home and overseas, he has made many important contributions not only to original knowledge but also to the structure and organisation of medical, dental and veterinary science and education. During both World Wars his skill in physiological experiment found valuable full-time application to chemical warfare and personnel research. But Starling's laboratory and Starling's inspiration, as he would proudly acknowledge, have made University College his real home. He and Mrs. Lovatt Evans will be sorely missed.

Lovatt Evans is a physiologist of the kind, now becoming rare, with a wide and critical knowledge of the whole field of human physiology. An excellent chairman and lecturer, a wise and understanding colleague with familiar contacts with physiologists the world over, his help and advice have been sought, and will continue to be sought, by those who have problems to solve, gaps of knowledge to make good —or posts to fill. One of his most important services to physiology has been in keeping alive and up to date Starling's "Principles of Human Physiology", an immense and continuing labour to which he has added the authorship or editorship of other books and monographs. The admirable performance of this task depended on, and perhaps added to, the breadth of his knowledge. Lovatt Evans, although retiring this year, is young in mind and activity, and physiologists will expect him to continue as busy as ever in the service of physiology.

Lovatt Evans's own original work has been largely concerned with the circulatory system : heart, lungs, blood, oxidation, frequently with a bias towards the metabolic and chemical side (his early love was chemistry). But among a wide range of interests are also numbered liver function, sugar metabolism, blood *p*H, lactic acid, adrenalin, etc. A suggestion he once made, probably forgotten by him, based on his knowledge of plain muscle, fired off an important train of research on the function of potassium in striated muscle and thence in non-medullated nerve. Some of the best things start, apparently casually, by suggestions of that kind, and Lovatt Evans's wide knowledge must have been responsible for many; his pupils and his friends owe much to him and them.

Dr. G. L. Brown, C.B.E., F.R.S.

Dr. G. L. Brown, who has been appointed to succeed Prof. Lovatt Evans, has been a member of the scientific staff of the Medical Research Council for the last fourteen years. Dr. Brown was a student at the University of Manchester, where he graduated in medicine in 1927, having taken a higher degree in physiology during his course of study. He left Manchester to become demonstrator and later lecturer in physiology under the late Prof. McSwiney at Leeds, where his researches were concerned with the motor innervation of the stomach. When Dr. Brown went to the National Institute for Medical Research in 1934, he joined in the programme of work in Sir Henry Dale's laboratory on the chemical transmission of nerve impulses ; to this work he made major contributions, especially in connexion with the role of acetylcholine in the conduction of impulses through sympathetic ganglia and from motor nerves to skeletal muscle. Since then he has much extended his researches in neurophysiology with full application and development of modern electrical methods ; the results of his work are important not only for their scientific interest but also for their clinical applications. During the Second World War, Dr. Brown gave distinguished service, as secretary of the Royal Naval Personnel Research Committee, both by organising and directly stimulating researches on conditions affecting the efficiency of naval personnel. The chair at University College will thus be occupied by a man who has established himself as a leader in physiology, and who will undoubtedly uphold the great traditions of the Laboratory of which he will have charge.

Prof. Solly Zuckerman, C.B., F.R.S.

The Lord President of the Council has announced that Prof. Solly Zuckerman, a member of the Advisory Council on Scientific Policy and of the Committee on Industrial Productivity, has been appointed deputy chairman of both bodies. The appointment, it is stated, will help to relieve the burden on the chairman, Sir Henry Tizard, who is also chairman of the Defence Research Policy Committee. Prof. Zuckerman will continue as chairman of the panel on imports and as professor of anatomy in the University of Birmingham.

Operational Research in Industry

In reply to a question asked in the House of Commons on January 19 on operational research in industry, the Lord President of the Council, Mr. Herbert Morrison, stated that it is the policy of the Government "to encourage all scientific activities which contribute to increasing the productivity and efficiency of industry. Operational research . . . is a term given in the recent war to the use of the scientific method for obtaining data on which executive decisions can be based. It has been employed by progressive firms in many industries for a number of years ; . . . there is certainly room for more of it. I have had a full report on its possibilities from a Panel of the Committee on Industrial Productivity. Several of the co-operative research associations, in particular the Cotton Research Association, the Iron and Steel Research Association and the Boot, Shoe and Allied Trades Research Association are doing well with it; and with the general expansion of facilities since the War, other research associations are already carrying out, or are planning, similar work." Mr. Morrison added that the Departments concerned will extend every encouragement to firms anxious to develop operational research within their respective organisations.

Submarine Geology : New French Annual

Oceanographers, who have long had good cause to be grateful to two well-known American institutions for their volume of "Collected Reprints" distributed each year, will welcome the recent institution of a comparable practice in France. It is manifestly impossible for individuals, and practicable only for a few major libraries, to maintain subscriptions and exchanges adequate to ensure the receipt of anything like all the important oceanographical papers which appear in the course of a year ; a serious difficulty resides, of course, in the fact that so many organs of publication are concerned. This latter point is evident on scanning a new volume just received, *Travaux du Laboratoire de Géologie Sous-Marine*, vol. 1 (1947). This is produced by the École Pratique des Hautes Études, 1 Rue Victor-Cousin, Paris 5e, under the superintendence of the director, Jacques Bourcart. It contains fifteen papers ; five are by Dr. Bourcart himself, of which three are on the sediments of the French continental shelf, one on sedimentation in the English Channel, and the other on the geology of the 'Iles Atlantides'. A paper by B. Brajnikov on the origin of the alluvial deposits of the Seine estuary is followed by a series of three by Prof. A. Cailleux, of which one discusses criteria for distinguishing between marine and fluviatile gravels. Dr. Claude Francis-Bœuf, who is the author of five of the remaining papers, is well known for papers already published on the processes involved in estuarial sedimentation—a topic of great present-day importance. He discusses the physicochemical factors of estuarial waters in connexion with the tropisms which affect eel migrations; sedimentation in estuaries; the oxygen content of fluviomarine muds, and the production and consumption of oxygen in the topmost surface layer of the latter. The last paper, by V. Romanovsky, is on the elasticity of agar-agar gels. All the papers included are reprints from various publications; the practice of issuing annual fascicules of reprints in special branches of study is very valuable to those directly interested.

International Committee on Nomenclature of Ocean Bottom Features

The International Union of Geodesy and Geophysics re-established, at its Oslo meeting in August 1948, an International Committee on the Nomenclature of Ocean Bottom Features under the chairmanship of Dr. J. D. H. Wiseman, British Museum (Natural History). The other members of this Committee are: Vice-Admiral J. D. Nares (*secretary*), International Hydrographic Bureau, Monaco; Dr. K. O. Emery, United States; Prof. H. H. Hess, United States; Prof. Hans Pettersson, Sweden; and Prof. Ph. Kuenen, Holland. The terms of reference of the Committee are: "To endeavour to establish in co-operation with the chart-making authorities, mechanisms for the International agreement on the nomenclature of submarine topographical features, as well as considering methods of presentation of marine topographical data on bathymetrical charts".

In order to facilitate the work of this International Committee, a British National Committee has been established under the chairmanship of Dr. J. D. H. Wiseman, with the following members: Mr. C. D. Ovey (*secretary*), British Museum (Natural History); Dr. J. N. Carruthers, Admiralty; Dr. L. H. N. Cooper, Marine Biological Association of Great Britain, Plymouth; Mr. H. F. P. Herdman, "Discovery" Investigations; Prof. W. B. R. King, Sedgwick Museum, Cambridge; Lieut.-Colonel R. B. Seymour Sewell, Zoological Laboratory, Cambridge; and Mr. J. A. Steers, president of St. Catharine's College, Cambridge. Early consideration will be given by this Committee to the various physiographical features found at the bottom of the oceans, and at a later stage to nomenclature and the presentation of data on bathymetrical charts. The British Committee would welcome and carefully consider any individual contributions or suggestion, which should be addressed to its secretary, Mr. C. D. Ovey, British Museum (Natural History), Cromwell Road, London, S.W.7.

Maternal Mortality in India

Inquiries into the causes of maternal mortality in Bombay, Calcutta, Delhi and Madras show that the data published in the reports of public health departments are unreliable and do not give an accurate picture of the real situation. These inquiries have been collated by Dr. S. Pandit in a report of the Indian Research Fund Association (No. 17; June 1948), and show that figures obtained by special investigations are considerably in excess of the numbers recorded in the public health reports. According to the reports of the executive health officer of Bombay, for example, the maternal mortality-rate for the year 1937 was 4·4 per 1,000 live births, whereas the rate determined by Dr. J. Jhirad for the same period was 13·5 per 1,000 live births. A clearer picture of the incidence of maternal mortality and of the causes responsible for it could be obtained only when a better system of recording all vital occurrences and of certification of the causes of death become widely established throughout India.

A statistical review of the figures collected during the investigations emphasizes the need for developing health services for prenatal care, adequate domiciliary and institutional midwifery services and close co-operation among the different agencies responsible for them. The reports recommend provision of facilities for institutional treatment for abnormal midwifery and puerperal sepsis cases. It is suggested that medical men and midwives in maternity services should have knowledge of preventive aspects of maternal care and, wherever possible, services of health visitors should be employed for educational and follow-up work. As anæmia forms one of the main causes of maternal deaths in India, its diagnosis and early treatment during pregnancy is of vital importance, and special attention should be paid to this condition. To improve the maternal health programme a service providing correct information on maternal deaths should be maintained and research into all aspects of maternal health should be conducted.

Fertility of Scottish Women

The widely held belief that decline in fertility among women is directly related to the degree of urbanization which has taken place in a community is not borne out by investigations which have been made by R. S. Barclay and W. O. Kermack (*Proc. Roy. Soc. Edin.*, Section B, 43, Part 11, No. 9). Surveying the trends of fertility in various sections of the population of Scotland from 1860 onwards, they gave special attention to the comparison of urban and rural areas. Difficulties in assembling the statistics arose because of the alterations introduced from time to time in the basis of classification used by the Registrar-General; but these were overcome in various ways. The areas investigated were the four chief cities, Glasgow, Edinburgh, Dundee and Aberdeen, and two groups of counties, one typical of the Highlands (Sutherland, Ross and Cromarty, Inverness and Nairn), and the other typical of the Borders (Peebles, Selkirk, Roxburgh and Berwick).

The results show that the fall in fertility in Scotland set in at about the same time in both urban and rural areas and, broadly speaking, the trends have run closely parallel in these two sections of the community. The fall in the urban section was neither earlier nor more rapid than that in the rural section. Other interesting findings are that the trend of legitimate fertility in the Border group of four counties contrasts strikingly with the trend in the Highland group, the fall in fertility in the former having set in earlier and proceeded more rapidly, while the fall in legitimate fertility in Aberdeen appears to have set in about twenty years later than in the other three large cities of Scotland.

Bird-Ringing in South Africa

THE first ringing of South African migratory birds was made early in December 1948 when the Cape Bird Club, under the direction of Dr. G. J. Broekhuysen of the University of Cape Town, used specially designed nets to catch European waders on the mud flats at Muizenberg, and marked them with leg bands inscribed "Zoo-Pretoria". The ringing scheme is sponsored by the South African Ornithological Society and is being extended over the Western Province. The birds caught were weighed before marking and release. Little stints, avocets, Sandwich terns, curlew-sandpipers, stilts and other familiar British birds-of-passage and nesting birds are expected to figure prominently in the South African experiment, which will not only elucidate further details about the winter quarters of European waders, and shore birds, but also determine whether many of the birds found at the Cape remain in the Union throughout the year, or nest elsewhere in Africa. Certain species like the black-winged stilt not only migrate from European nesting haunts but also breed in parts of Africa.

For many years now migratory birds ringed in European nesting haunts have been recovered at winter haunts in Africa. Notable among these have been the European swallow, the house-martin, the common swift, the cuckoo, the nightjar, the red-backed shrike and the Sandwich tern and the white stork. More than a score of common swallows marked when nesting or as nestlings in the British Isles have been recovered in South Africa, and the Sandwich tern from Britain has been recovered in Natal.

Research at the University of Sydney

A COMMITTEE appointed by the vice-chancellor has prepared an interesting description of the original scientific work done at the University of Sydney during the years 1944 and 1945, so continuing the account set out in the previous publication for the years 1942–43. The report shows that, despite the absence of many members of staff on war service and the greater amount of teaching duties undertaken by those who remained at the University, much valuable work was carried out and a considerable number of young workers were trained to undertake research. Subjects of research are listed under the headings: art, law, medicine, science, engineering, veterinary science, agriculture, economics and social studies.

University of Leeds

THE Council of the University of Leeds has announced the receipt of the following gifts, among others: a sum of £200 given to Prof. S. Brodetsky by his friends on his retirement from the chair of applied mathematics and presented by him to the University for the establishment of a prize in mathematics; £1,500 given to the Inorganic and Physical Chemistry Department by the Royal Society for the development of a special Weissenberg goniometer.

The following appointments have been made: Dr. D. G. Christopherson, fellow and bursar of Magdalene College, Cambridge, to be professor of mechanical engineering from September 1, 1949, in succession to the late Prof. W. T. David; Mr. R. Holliday, to be senior lecturer in agriculture.

Royal Society Lectures for 1949

THE Croonian Lecture for 1949 will be delivered on June 30 by Dr. D. W. Bronk, foreign secretary of the National Academy of Sciences and chairman of the National Research Council of the United States. As director of the Johnson Institute for Medical Physics in the University of Pennsylvania, he has greatly influenced the development of biophysics, his special field of work being the physiology of the nervous system; his recent work has been on the oxygen consumption of the brain. The Croonian Lecture was founded by Dr. William Croone, one of the original fellows of the Royal Society, "for a lecture and illustrative experiment for the advancement of natural knowledge on local motion"; the first lecture was delivered in 1738.

The Bakerian Lecture for 1949 will be delivered on May 12 by Prof. H. Raistrick, professor of biochemistry in the University of London. This Lecture was founded by Mr. Henry Baker, "for a yearly oration or discourse by one of the Fellows on some part of natural history or experimental philosophy"; the first lecture was delivered in 1775.

The Wilkins Lecture for 1949 will be delivered on December 15 by Prof. E. N. da C. Andrade, Quain professor of physics in the University of London. The Wilkins Lecture on the history of science was founded in 1947 by Mr. J. D. Griffith Davies, a recent assistant secretary of the Society, who delivered the first lecture entitled "John Wilkins and the Royal Society" in 1948.

Goethe Bicentenary Lectures

A SERIES of six festival lectures in commemoration of the bicentenary of the birth of Goethe will be held at University College, London, under the auspices of the British Goethe Festival Society, beginning on March 3. The first lecture is by Prof. L. A. Willoughby, on "The Living Goethe". The remaining lectures are by Dr. G. P. Gooch, on "Goethe, the Liberal-Conservative" (March 10); Prof. F. Blume, "Goethe and Music" (March 17); Dr. Karl Wolff, speaking in German, on Goethe's religion (April 21); Prof. H. Friedmann, "Goethe's Morphology" (April 28); Mr. L. L. Whyte, "Goethe's Single View of Nature and Man" (May 5). The lectures are at 5.30 p.m. and are open to the public without fee or ticket.

First International Congress of Biochemistry

THE First International Congress of Biochemistry will be held in Cambridge during August 19–25, 1949. The Congress is under the presidency of Prof. A. C. Chibnall, and for the reading of papers and for discussion it is organised into twelve separate sections, each with its own chairman, as follows: animal nutrition and general metabolism, Sir Jack Drummond; microbiological chemistry (vacant through the recent death of Miss Marjory Stephenson); enzymes and tissue metabolism, Prof. R. A. Peters; proteins, Dr. K. Bailey; clinical biochemistry, Prof. E. J. King; structure and synthesis of biologically important substances, Prof. A. R. Todd; cytochemistry, Prof. J. N. Davidson; biological pigments: oxygen carriers and oxidizing catalysts, Prof. D. Keilin; hormones and steroids, Prof. F. G. Young; chemotherapy and immunochemistry, Sir Charles Harington; plant biochemistry, Dr. C. S. Hanes; industrial fermentations, Mr. H. J. Bunker. In addition to the meetings of the sections, there will be Congress lectures and visits to research stations and laboratories. The fee for membership of this Congress is £2. Applications and inquiries should be addressed to the Honorary Organiser, First International Congress of Biochemistry, 56 Victoria Street, London, S.W.1.

Conference in London on Prehistoric Homesteads

A Conference on "Prehistoric Houses and Farms, and Some Later Comparisons" will be held by the Prehistoric Society in collaboration with the University of London Institute of Archæology during April 22–24, 1949, at the latter's address at Inner Circle, Regent's Park, London, N.W.1. Admission to the Conference is free to members of the Society and of the Institute, and for all others the price of admission is 5*s*., inclusive for all days, tickets being obtainable at the door only. The honorary secretary of the Conference is Mr. T. G. E. Powell, Department of Prehistoric Archæology, University, Liverpool, 3.

Medical Research Council: Carcinogenic Action of Mineral Oils

The Medical Research Council has appointed the following to advise and assist in the prosecution of research on the carcinogenic action of mineral oils: Prof. T. Ferguson, professor of public health, University of Glasgow (*chairman*); Colonel S. J. M. Auld, chairman of Research Group No. 2, Institute of Petroleum; Prof. J. W. Cook, regius professor of chemistry, University of Glasgow; Prof. A. Haddow, professor of experimental pathology, University of London, and director of the Chester Beatty Research Institute, Royal Cancer Hospital, London; Dr. J. O. Irwin, senior research worker, Medical Research Council Statistical Research Unit, London School of Hygiene; Prof. J. R. Squire, professor of experimental pathology, University of Birmingham; Dr. D. L. Woodhouse, officer-in-charge, Cancer Research Laboratory, University of Birmingham; Dr. J. M. Rogan, Medical Research Council Headquarters Staff (*secretary*). In addition, the Ministries of Fuel and Power, Health, and Ministry of Labour and National Service, have nominated representatives who will attend meetings when matters of interest to these departments are likely to arise.

Royal Astronomical Society: Officers for 1949

At the annual general meeting of the Royal Astronomical Society held on February 11, Prof. W. M. Smart, regius professor of astronomy in the University of Glasgow, was elected president. The following were also elected officers of the Society: *Treasurer*, Sir Harold Spencer Jones; *Secretaries*, Prof. R. O. Redman and Dr. A. Hunter; *Foreign Secretary*, Prof. F. J. M. Stratton.

The Night Sky in March

Full moon occurs on March 14d. 19h. 03m., U.T., and new moon on March 29d. 15h. 11m. The following conjunctions with the moon take place: March 13d. 06h., Saturn 3° S.; March 23d. 14h., Jupiter 5° N.; March 28d. 05h., Mercury 0·7° N. Mercury rises 45 minutes before the sun at the beginning of the month and 20 minutes before sunrise at the middle of the month, and is unfavourably placed for observation. Venus is too close to the sun during March for favourable observation. Mars is in conjunction with the sun on March 17 and cannot be seen during the month. Jupiter rises at 5h. 04m., 4h. 17m. and 3h. 22m. at the beginning, middle and end of the month respectively, and can be observed low down during the early morning hours in the constellation of Sagittarius. Saturn, in the constellation of Leo Major, can be observed throughout most of the night, setting at 6h. 45m., 5h. 45m. and 4h. 45m. at the beginning, middle and end of the month respectively. Occultations of stars brighter than magnitude 6 are as follow: March 5d. 21h. 49·3m., δ Arie. (*D*); March 6d. 18h. 40·3m., 33 Taur. (*D*); March 8d. 20h. 21·8m., 136 Taur. (*D*); March 10d. 22h. 24·8m., ω Canc. (*D*). *D* refers to disappearance, and the latitude of Greenwich is assumed. Spring equinox commences on March 20d. 23h.

Announcements

The following elections have been made to the Paris Academy of Sciences: M. Constantin Dawidoff, to be *correspondant* for the Section of Anatomy and Zoology, in succession to the late Prof. Johan Hjort; M. André Donatien, to be *correspondant* for the Section of Rural Economy, in succession to the late M. D. Prianichnikov.

The following appointments in the University of Birmingham have been announced: Dr. F. Morgan, to be reader in chemical engineering; Mr. M. Shaw, to be Tube Investments Research Fellow in the Department of Engineering Production. The following have been appointed lecturers in the subjects as indicated: Dr. G. M. Burnett (chemistry); Dr. W. G. Overend (chemistry); Mr. D. A. Bell (electrical engineering); Mr. J. C. Henderson (electrical engineering).

The Council of the University of Sheffield has made the following appointments: Dr. Quentin H. Gibson, lecturer in physiology, to be senior lecturer in physiology; Frank A. Benson, lecturer in electrical engineering; Margaret Gunn, cancer research assistant (to work in the Department of Pathology under the auspices of the British Empire Cancer Campaign).

Dr. C. West has relinquished the post of superintendent of the Ditton Laboratory of the Department of Scientific and Industrial Research on transfer to the headquarters of the Director of Food Investigations, 20A Regent Street, Cambridge, for special duty. He is succeeded by Dr. R. G. Tomkins, of the Low Temperature Research Station, Cambridge. The Laboratory will continue to work mainly on problems of preserving fresh fruit and vegetables by refrigeration.

The trustees of the Ramsay Memorial Fellowships for Chemical Research invite applications before April 16 for these fellowships, one of which will be limited to candidates educated in Glasgow. The value of each fellowship will be £400 per annum, with a grant for research expenses not exceeding £100 per annum. Particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1.

The second 'chemical day' at Clausthal will be held, under the auspices of the Harz Section of the German Chemical Society in the British Zone, during March 4–5.

Errata.—In the account in *Nature* of December 25, p. 985, of the Nutrition Society's meeting on "Anti-vitamins", Dr. L. J. Harris was incorrectly reported to have stated that the active principle of 'Gammexane' is hexachlorobenzene; it should be, of course, the gamma isomer of benzene hexachloride (hexachloro*cyclo*hexane). The statement attributed to Dr. E. Kodicek that live yeast contains thiaminase is also incorrect.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption of Star-Producing Radiation Under Ice

MEASUREMENTS of the absorption of the radiation responsible for the nuclear disintegrations observed in photographic emulsions have been made in the atmosphere and under lead. The star intensity I, at a depth h gm./cm.^{2} from the top of a medium, can be represented by

$$I = I_0 \exp(-h/l),$$

where l is the range of the star-producing radiation in gm./cm.^{2}.

Experimental ranges of 160 gm./cm.^{2} and 140 gm./cm.^{2} have been obtained in air by George[1] and Perkins[2] respectively. By considering the single tracks which accompany stars, and which in number he showed to be proportional to the number of stars, Perkins deduced a value of 320 gm./cm.^{2} for the range of the star-producing radiation in lead. He thus concluded that the stars are produced by unstable particles.

Considering the stars proper, George obtained a range of 310 gm./cm.^{2} in lead and suggested that the increased range in lead compared with that in air could be explained by the different atomic weights of the absorbers, instead of by their different densities. To distinguish between these two possibilities, we had already started an experiment to determine the absorption of the radiation under ice, which, although having a density approximately a thousand times that of air, has nearly the same atomic weight.

If we assume that the primaries have a cross-section for star-production proportional to the geometrical cross-section of the nucleus, we can calculate the expected ratio of the range in air to that in ice. Since the hydrogen in the ice is not disintegrated, the cross-section for star production depends only on the oxygen nuclei present. Hence we get

$$l_{\text{air}} : l_{\text{ice}} = 1 : 1{\cdot}16.$$

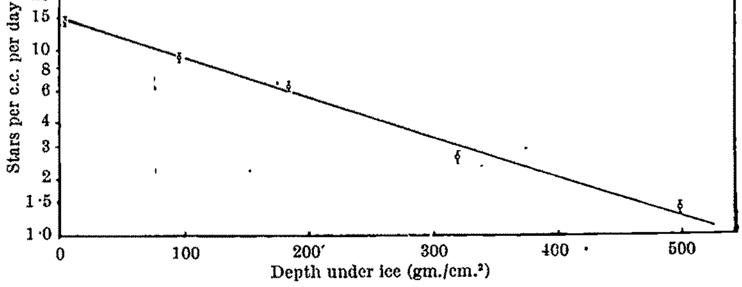
A calculation by George yields

$$l_{\text{air}} : l_{\text{lead}} = 1 : 2{\cdot}4,$$

which is in good agreement with the mean experimental ratio of 150 : 315 = 1 : 2·1.

On this hypothesis, we should expect a range in ice only slightly greater than that in air, whereas, if we suppose that the stars are produced by an unstable radiation, the absorption being proportional to mass, we find that the observed range in ice should be indistinguishable from that in lead.

Ilford *C*2 emulsions, 100 μ thick, coated on glass, were wrapped in black paper and packed in wax-coated cardboard boxes. These boxes were lowered, keeping the plates horizontal, into a narrow crevasse (about 10 cm. wide) in a glacier at the Jungfraujoch, height 3,650 m. Plates were thus exposed at the following depths below the surface of the ice for fifty days: 0 m., 1 m., 2 m., 3½ m. and 5½ m. By the end of the experiment the plates had been further covered by about 50 cm. of lightly packed snow. Taking an average value of 0·9 for the density of ice and allowing 5 gm./cm.^{2} for the snow coverage, we obtain the depths of exposure in gm./cm.^{2}. The experiment was commenced within one week of manufacture of the plates (four days were spent below 1,500 m., and three days below 200 ft. of rock at 3,650 m.) and the processing completed within four days of the termination of the experiment. We have not corrected our results for pre- or post-exposure.



Using a 4-mm. objective, the plates were scanned for stars at the rate of 1 sq. in. per day, and then re-scanned at half this speed. Using the results of both scannings, we are sure that not more than 1 per cent of the stars have been overlooked.

We have defined a star as having at least two prongs, one of which must have a range of more than 60 μ of emulsion, and we have only included those two-track stars which could definitely be distinguished from large-angle deflexions in single tracks. We have thus under-estimated the true number of two-track stars, but have included the certain ones in order to better our statistics. A significantly different result is not obtained by considering only stars with three or more prongs.

The number of stars per c.c. per day has been plotted on a logarithmic scale against the depth in gm./cm.^{2} of ice. The deviations shown are the calculated probable errors on the finite number of stars obtained.

Depth under ice in gm./cm.^{2}	5	95	185	320	500
No. of stars observed	138	102	91	84	78
Area of plates in cm.^{2}	19	22	29	64	110
Stars/c.c./day	14·3±0·8	9·1±0·6	6·3±0·4	2·6±0·2	1·4±0·1

The range of the star-producing radiation as calculated from the slope of the graph is 200 gm./cm.^{2}, which is 1·33 times the mean range (150 gm./cm.^{2}) in air. This is in fair agreement with the ratio calculated, assuming that the cross-section for star production is proportional to the geometric cross-section of the nucleus; and from the range of 200 gm./cm.^{2} we calculate an effective cross-section of 0·15 barns for an oxygen nucleus.

We thus conclude that the stars are produced by stable particles, their range depending on the atomic weight of the absorber. It may here be noted that the radiation responsible for the single tracks has a range of 200 gm./cm.^{2} in ice, thus confirming Perkins's earlier conclusions that the stars and single tracks are in equilibrium. This work is being reported fully elsewhere[3].

We should like to express our indebtedness to Prof. A. von Muralt and Dr. R. Stämpfli for providing facilities at the Jungfraujoch Scientific Station during the course of this experiment.

J. B. Harding
S. Lattimore
T. T. Li
D. H. Perkins

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Imperial College,
London, S.W.7.
Jan. 12.

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[1] George, E. P., *Nature*, **162**, 333 (1948).
[2] Perkins, D. H., *Nature*, **160**, 707 (1947).
[3] Lattimore, S., *Phil. Mag.* (in the press).

Adenosine Triphosphate and Muscular Contraction

It is commonly stated, on evidence obtained with muscle extracts, that the energy of muscular contraction is derived in the first instance from the breaking of the terminal energy-rich phosphate bond of adenosine triphosphate. Why not try to find out whether it really is, not in muscle extracts which cannot contract but in muscles which can ?

The total energy obtainable from this source, from the whole of the adenosine triphosphate present in muscle, is calculated to be about 0·05 calorie per gm. In the maximal contraction of a frog's muscle at 20° C., this would last only about 0·5 sec. Before then, however, according to current hypothesis, the restoration of the adenosine triphosphate at the expense of the energy of creatine phosphate breakdown (the 'Lohmann reaction') is well under way; the difficulty of resolving chemical events occurring so rapidly might very well be regarded as insuperable. But there are two easy ways around this obstacle: (i) to use a slower muscle; and (ii) to work at a lower temperature. The liberation of energy in toad's muscle during maintained contraction is only half as rapid as in frog's, in tortoise's only 1/10 to 1/20 as rapid; and its rate can be diminished about nine times by lowering the temperature to 0° C.

One cannot be sure how fast the adenosine triphosphate (if it *is* broken down in contraction) would be restored by the Lohmann reaction at 0° C. during maintained activity. Apart from such restoration, its breakdown in toad's muscle would be complete in 10 sec., in tortoise's in 50–100 sec. Probably in times of this order a balance would be reached between breakdown and restoration, at a level substantially different from that at rest. The slowness of the processes involved, particularly in tortoise's muscle at 0° C., should allow ample time for the necessary treatment preliminary to chemical analysis, and good resolution in time could probably be obtained. The experiment might allow a clear decision to be reached as to whether adenosine triphosphate is really concerned with the contractile process as such, or whether —like every other chemical change known to occur in muscle—it is part of the mechanism of recovery.

Prof. T. B. L. Webster recently provided an epigram to be posted in my laboratory: Ὑπόθεσις ἔλεγχους μὴ ἀποδεχομένη οὐκ ἐξοιστέα, which means that hypotheses should not be put forward that do not admit of test. The hypothesis that adenosine triphosphate breaks down during the contraction of a living muscle ought not to be left in that category, but only biochemists can remove it.

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Jan. 10.

Meson Masses and the Principle of Reciprocity

In two previous letters, M. Born and H. S. Green have proposed a new theory of elementary particles and quantized fields and applied it to the case of mesons. We shall give some numerical results which follow from the theory.

There is an infinite number of particles predicted by this theory, the rest-masses of which are the square roots of the solutions of certain transcendental equations, namely,

$$\mathbf{L}_n^{(1)}(x) = 0, \tag{1}$$

where $\mathbf{L}_n^{(1)}(x)$ are the Laguerre polynomials of the first kind. The first of these were given in the first paper, and it is easy to calculate the following ones with the help of a well-known recurrence formula. We have solved the equations (1) and found the following values for their roots:

n	x				
1	2				
2	1·26	4·73			
3	0·93	3·31	7·75		
4	0·74	2·57	5·73	10·9	
5	0·53	2·11	4·61	8·40	14·26

These figures are connected with the masses in the following way: let a and b be the absolute length and momentum such that $ab = \hbar$. Then the wave equation for particles belonging to a given value x is

$$(p^2 - E^2 - xb^2)\,\psi = 0. \tag{2}$$

Hence one has for the mass

$$m = b\sqrt{x}/c. \tag{3}$$

Consider the first particle corresponding to $n = 1$ and replace b by $a/\hbar$, then

$$m = \hbar\sqrt{2}/ac. \tag{4}$$

Now we make the assumption which at the present state of the investigation cannot be justified from theoretical arguments but seems rather plausible, namely, that a is the classical radius of the electron, given by

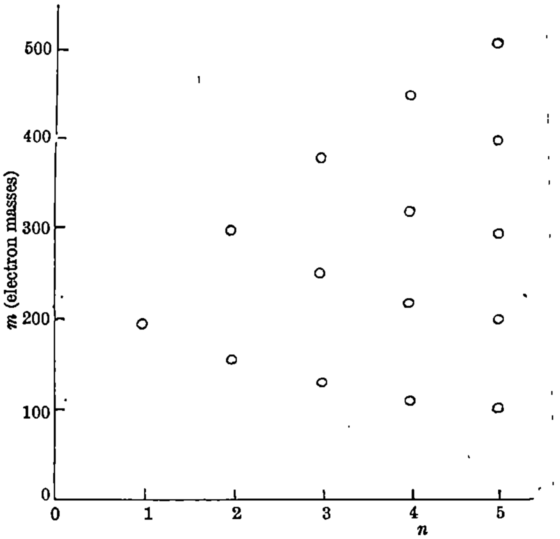
$$a = e^2/\mu c^2, \tag{5}$$

where μ is the mass of the electron. If this is substituted in (4) one obtains

$$\frac{m}{\mu} = \frac{\hbar c}{e^2}\sqrt{2} = 137\,.\,\sqrt{2} \simeq 194. \tag{6}$$

We venture the suggestion that this value of m is the mass of the most stable meson. Indeed, the experimental determinations of the mass of the mesons which are observed at sea-level, and are therefore presumably the most stable ones, is given by the Bristol workers as about 200 μ, in good agreement with our calculated value. (According to the report by J. A. Wheeler on the Pocono Conference, the value found at Berkeley is 192 μ.)

The accompanying figure gives the masses of the other mesons, based on the same assumption (5). One sees that the next most stable meson of higher mass has $m = 300\,\mu$, which corresponds very well to the observed π-mesons. The ratio of the two first calculated masses is 1·54, in good agreement with the results obtained in Bristol, while the Berkeley experiments are reported to give 1·32.



But there are many more less stable mesons predicted, and the spreading of the values obtained by different observers might be very well explained by the assumption that they had to do with different types of particles.

A preliminary investigation of particles with spin has shown that the rest-masses given by this theory are of the same order of magnitude except one, which is zero. Hence the observed small value of the mass of the electron must be of secondary origin, namely, a self-energy produced by the surrounding electromagnetic field. Investigations of this question are in progress.

Max Born
Antonio E. Rodriguez
Department of Mathematical Physics,
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Nov. 9.

Optical Sensitization of Lead Sulphide Layers made without Oxygen

Information regarding the preparation of photosensitive lead sulphide layers has already been published[1,2], the preparation involving the introduction of oxygen as an essential impurity. Sensitive layers have now been made without the use of oxygen by forming the lead sulphide layer by evaporation in sulphur vapour.

During the course of this work, it was found that if the layer was collected on a surface at a temperature of about 100° C., it was not normally photosensitive, but could be made so by prolonged illumination by visible light of high intensity, while the cell was maintained at a low temperature (90° K.). The photosensitivity (defined as the decrease, $\Delta R/R$, in cell resistance for unit incident intensity) was measured at a wave-length of 1·2 μ, using radiation of intensity small compared with that of the sensitizing light, which was shut off while measurements were being made.

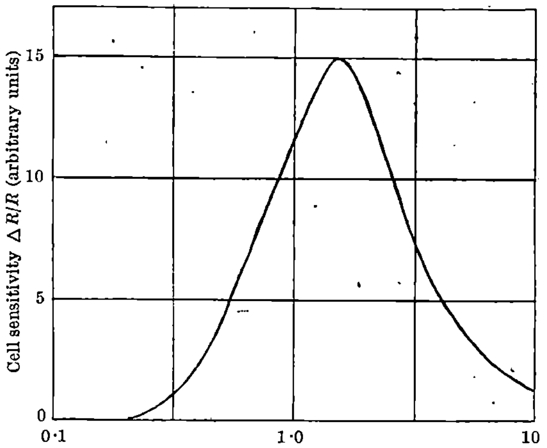

Fig. 1

The variation in cell sensitivity and dark conductivity during sensitization are shown in the figure, the time-scale being logarithmic. If at any time the sensitizing light is removed and the cell maintained at 90° K. in the dark, it returns slowly to its original condition. This process takes many hours at 90° K., but may be accelerated by warming slightly, suggesting that thermally metastable levels (that is, electron traps) are filled during sensitization. Sensitization at 77° K. proceeds more quickly than at 90° K., the subsequent decay proceeding more slowly, thus confirming the above hypothesis. Measurement of the thermal decay of the traps indicates that they have a depth[6] of about 0·3 eV.

The time taken to reach maximum sensitivity or a chosen value of the dark conductivity is inversely proportional to the sensitizing intensity, provided that this time is short compared with the mean decay time of the traps. The sensitivity and dark conductivity are thus a function of the product (sensitizing intensity × time), and it is found that the conductivity is described by the equation:

$$\sigma = \sigma_0 + c \log (I.t + 1),$$

where I is the sensitizing intensity in arbitrary units.

An equation of this type describes the number of electron traps filled on illumination of silver halide crystals[3] and zinc sulphide phosphors[4]. It seems

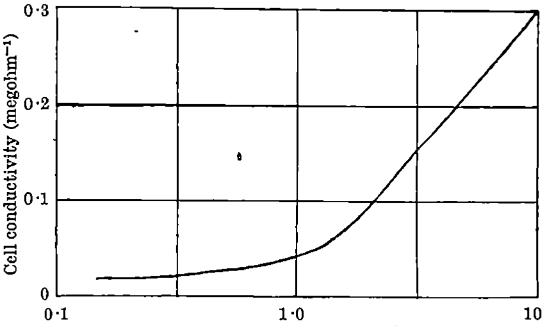

Fig. 2

reasonable to suppose, therefore, that the increase in dark conductivity is determined by the number of mobile positive holes left when the excited electrons are trapped. Thermo-electric power measurements confirmed that the conductivity was due to positive holes.

The sensitization spectrum was found to be very similar to the photoconductivity spectrum of free sulphur. In view of the conditions of preparation, it is likely that specks of free sulphur exist in the layer; and hence the sensitization process entails the raising of electrons from the filled band of the sulphur crystals into the conduction band, from which they are afterwards trapped.

There is no completely satisfactory explanation of the rise and subsequent fall in cell sensitivity as sensitization proceeds. It is analogous to the variation in cell sensitivity found during the manufacture of normal lead sulphide cells as the layer moves from an excess to a deficit semiconductor[2]; but it is curious that the point of maximum sensitivity does not coincide with a point of maximum dark resistance. The time constant of the cell (defined as the time taken for a signal to decay to $1/e$ of its original value) also passes through a maximum at about the same time as maximum sensitivity is reached.

The spectral response of the cells moves to longer wave-lengths during sensitization, the spectral limit reaching about the value found for normal lead sulphide cells at 90° K. when maximum sensitivity is reached[5].

The above work was carried out in the laboratories of the Telecommunications Research Establishment, Great Malvern, and thanks are due to the Chief Scientist, Ministry of Supply, for permission to publish this note.

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Telecommunications Research Establishment,
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Sept. 24.

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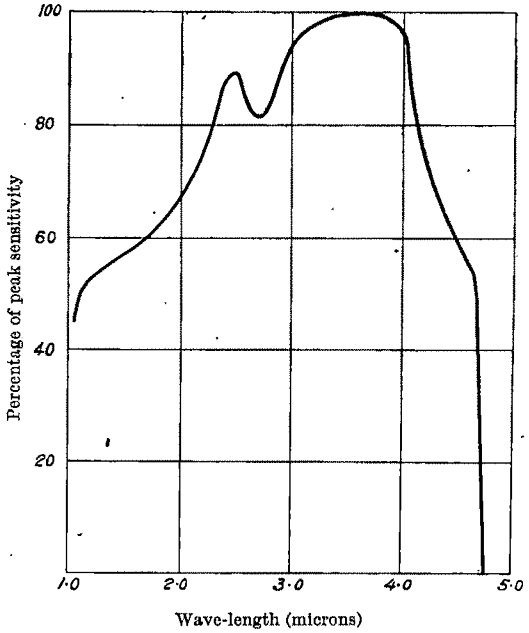
Lead Selenide Photoconductive Cells

The superiority of lead selenide photoconductive cells over lead sulphide cells and over purely thermal infra-red detectors in the 3–4 μ region has already been described[1,2]. The preparation of these sensitive layers has always been by an evaporation method[3,4] analogous to that previously used for lead sulphide[5]. Chemical deposition processes[6,7] for the preparation of lead sulphide cells have been further developed by us, until comparable sensitivity at room temperature and greater sensitivity at low temperatures than those obtained with evaporated cells are available.

We have recently made successful trials of a chemical process for preparing lead selenide layers, based on information about a process tried with unknown results by Sommer in Germany[8]. A thin film of lead sulphide is first deposited on the cell blank to act as a seed layer for the growth of the lead selenide microcrystals. This film is prepared by a short immersion in a bath of lead acetate and thiourea, while this is gradually made strongly alkaline. The lead selenide is then deposited on this seed layer from a bath of lead acetate and selenourea; this reaction is much slower than the lead sulphide deposition and usually requires about an hour to develop a sufficiently thick layer of lead selenide. The lead selenide film is then subjected to a partial oxidation by baking in air to about 300° C. for 10–15 min.



The sensitivity of these lead selenide cells when cooled with liquid air is such that a signal equal to noise is obtained for 10^{-8} to 5×10^{-9} watt/mm.² of 200° C. black-body radiation, 800 c./s. interruption frequency with 30 c./s. band-width. A typical spectral distribution curve at liquid air temperature is shown in the accompanying graph. It will be observed that this type of lead selenide cell has a broad maximum at 3–4 μ, in this respect resembling the cells reported by Starkiewicz[4]. The position of the long-wave cut-off could not be exactly determined owing to the use of fused silica windows, which absorb strongly in the 4·5–5 μ region; good sensitivity, however, exists up to at least 4·6 μ.

These cells have so far only exhibited appreciable sensitivity at low temperatures, such as those of solid carbon dioxide and liquid air. The investigation is, however, still in an early stage, and these preliminary results are encouraging.

We desire to thank the directors of the British Thomson-Houston Co., Ltd., for permission to publish this note.

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Aug. 26.

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Plastic Deformation of Optical Glass

I DESCRIBED recently a form of hardness micro-tester which permits light loads to be applied to a diamond indenter of pyramidal form as a means of determining the hardness figures of minute individual crystals in a mosaic[1]. It is also possible with the same instrument to draw the loaded indenter across a surface and to determine the hardness figure by means of a scratch test.

It was intended by this latter means to attempt to assess the hardness figures of many of the known types of optical glass, and a beginning was made in this direction. In addition, the opportunity presented itself of observing the form of the resulting fracture when the loaded indenter was used in a static manner and brought into contact with a plane polished glass surface. It was then discovered that a lightly loaded pyramid diamond left a perfectly defined and lasting impression on the polished surface. Thus, in the case of borosilicate crown and extra dense flint glasses, perfect impressions were formed with loadings up to about 50 gm.; with loadings of 100 gm., fractures appeared emanating generally from the corners of the square impression, and at some intermediate loadings fractures sometimes appeared after a short interval of time (Fig. 1).

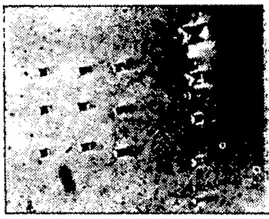

Fig. 1

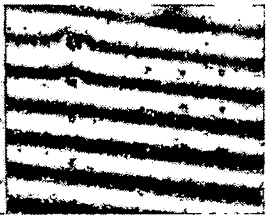

Fig. 2

Fig. 1. Nine impressions under load of 20 gm. Single impressions under loads of 100, 50, 20, 10 and 5 gm. × 200

Fig. 2. As Fig. 1, but with the addition of interference fringes which indicate a raised rim around the two larger impressions. (Wave-length, 546 mμ.) × 200

With borosilicate crown glass 509/650, the diagonals of the impression under a load of 50 gm. measured about $12{\cdot}3\,\mu$, giving a hardness figure of 613; and under identical conditions the hardness figure for extra dense flint glass 650/337 was 433 with the diagonals measuring $14{\cdot}6\,\mu$.

The interesting fact is that the surface layer was found to be sufficiently plastic to take an impression. Thus, with a loading of 100 gm. the volume of the displaced borosilicate crown glass was $115\,\mu^3$, and an interference test showed a raised rim of glass around the depression (Fig. 2). The volume of glass raised above the original surface was found to be about $90\,\mu^3$, but accurate measurement was difficult and there may well be perfect correspondence.

In view of the uncertainty which exists regarding the nature of a worked glass surface[2,3], similar tests were carried out on a newly fractured and on a fire-polished surface of the same borosilicate crown glass. No difference in behaviour was noted and no evidence was forthcoming to support the presence of a soft superficial layer of glass on the optically worked specimen.

E. WILFRED TAYLOR

Cooke, Troughton and Simms, Ltd.,
Haxby Road, York. Nov. 5.

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A Theoretical Comparison of the Performance of Stationary-Target Crystallographic X-Ray Tubes Operating on Alternating and Direct Voltages

IT has been suggested that if a normally self-rectifying crystallographic X-ray tube is operated on D.C. instead of A.C., it should be possible approximately to double the power input to a tube and therefore similarly to increase the X-ray output. Unfortunately, this does not take into account the fact that the maximum target loading, determined by consideration of the heat dissipation, is normally obtained in a tube using A.C., so that at first sight it would seem to be impossible to increase the power input by operating the tube on D.C. However, as Terrill and Ulrey[1] point out, the temperature of the focal spot will fluctuate with each half-cycle in the case of A.C.; if the maximum temperature obtained is equal to the maximum permissible temperature for the target, which is also the steady temperature in the D.C. case, it follows that the average temperature will be lower for A.C. than for D.C. Thus the power input with A.C. must be made smaller than with D.C. in order that the maximum temperature shall not exceed the safe value. Terrill and Ulrey give no actual figures for this difference, but DeGraaf and Oosterkamp[2] state that with a four-valve circuit the maximum load is roughly 15 per cent higher than for A.C., and that for a well-smoothed 'Greinacher' voltage it is about 20 per cent higher.

It can be shown theoretically, moreover, that for a *given* power input the mean intensity of characteristic radiation is slightly greater for a D.C. high-voltage supply than for A.C., and so also, under certain conditions, is the ratio of intensities of characteristic and white radiations.

The relation[3] between the intensity I of the characteristic radiation, the current i passed by the tube, and the voltage V applied to it, is given by:

$$I = Ai\,(V - V_k)^{1\cdot5},$$

where V_k is the critical voltage for the material of the anode, and A is a constant.

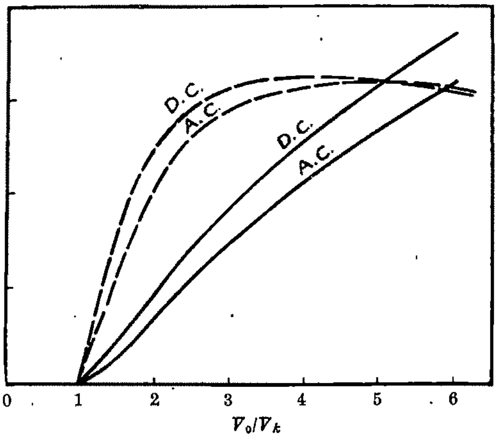
In the case of D.C., values of voltage and current can be substituted directly in this equation; but for the A.C. case it is necessary to obtain the mean value of this function over the whole voltage cycle, and this involves the integration:

$$I = A\,\frac{1}{\tau}\int_0^{\tau} i(V - V_k)^{1\cdot5}\,dt,$$

where τ is the periodic time of the A.C. supply, and V is the instantaneous voltage at any point in the cycle. This integration has been carried out numerically, including only that part of the cycle where $V > V_k$.

The accompanying figure shows the variation of the intensity I with voltage V_0 for both A.C. and D.C., the mean target loading, that is, the power input, being the same in both cases. In the A.C. case, V_0 represents peak voltage, and it has been assumed that the voltage wave-form is purely sinusoidal; in the D.C. case, V_0 has the same value as V.

The curves have only been drawn to values of $V_0/V_k = 6$, as at higher voltages it has been shown



Full lines, variation of intensity; broken lines, variation of contrast

practically that the intensity approaches asymptotically a limiting value[4].

Another important factor in crystallography is the ratio of the intensities of the characteristic and white radiations, which we might designate as contrast. The white radiation intensity[5] is proportional to iV^2, and hence for the D.C. case, a measure of contrast (C) is given by:

$$C = A(V - V_k)^{1\cdot 5}/A'V^2.$$

In the case of A.C., integration is again necessary, the relation being:

$$C = A \int_0^T i(V - V_k)^{1\cdot 5}\,dt/A' \int_0^T iV^2\,dt.$$

The variation of contrast with voltage for the two cases is also shown in the figure. It will be seen that the contrast curves each show a definite maximum, occurring when V_0 is equal to $4V_k$ for D.C. and $5V_k$ for A.C., the former being about $1\frac{1}{2}$ per cent higher than the latter. Thus if the high-tension voltage is increased above these values, although there may be a slight increase in intensity there is a slight decrease in contrast. This explains the use of a voltage of about $5V_k$ to obtain the best results with the typical crystallographic X-ray set, the desired intensity being obtained by varying the emission current. This has no effect on the contrast, since both line and background intensities are affected to the same degree by altering the current.

The intensity curves show that, for a constant power input, and working at the usual voltage of $5V_k$, the theoretical increase in intensity obtained by using D.C. is about 18 per cent. This, combined with the possibility of a 20 per cent increase in the power input using D.C., results in a total increase in intensity of approximately 40 per cent.

It is therefore concluded that the increase in intensity obtained by operating a stationary target X-ray tube on a D.C. high-tension supply as opposed to an A.C. supply, although advantageous in itself, is considerably outweighed by the additional expense and maintenance of a D.C. supply. The ratio of characteristic radiation to white radiation, referred to here as contrast, is practically unchanged.

We thank Sir Arthur Fleming, director of research and education, and Mr. B. G. Churcher, manager of the Research Department, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish this note.

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Manchester.

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Metallic Delay Lenses

AN experimental study of the metallic delay lens described by Kock[1] has been made in this Establishment, using a lens constructed of parallel strips as in Fig. 1, the E vector being normal to the line of the strips. The dimensions were such that Kock's formula for refractive index

$$n = \sqrt{1 + \frac{\pi}{4} s^2 N},$$

where s is width of strips and N is number of strips per unit area viewed end on, gave the value 1·41 for n. The predicted cut-off wave-length was 1·8 cm.

An experimental investigation of the optics of the lens gave a refractive index of 1·71 at $\lambda = 10\cdot 0$ cm. The same degree of accuracy could not be achieved with $\lambda = 6\cdot 0$ cm., but there was no measurable difference in the value of n. For $\lambda = 3\cdot 0$ cm. the lens was practically opaque.

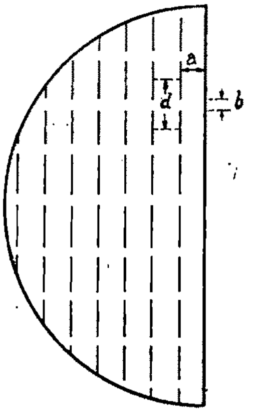

Fig. 1. Metallic delay lens

A new formula for refractive index has been calculated on the assumption that the refracting medium behaves similarly to a transmission line the characteristic impedance of which is that of air loaded at equal intervals by a capacitance, which depends on the width of the metal strips and the gap between them. The method of calculation is similar to those employed by Macfarlane and others in the study of wave-guides[2]. The computed values of refractive index are shown in Fig. 2, the cut-off wave-length being $\lambda = 2\cdot 97$ cm.

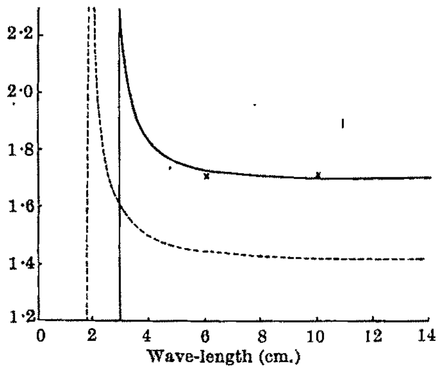

Fig. 2. Refractive index of metallic delay lens. ×—×—, observed points; full line, new formula; broken line, Kock's formula. Two vertical lines, broken and full, show cut-off at $\lambda = 1{\cdot}8$ and 2·97 cm., respectively

Over the range of wave-lengths for which the refractive index is constant, its value is given by:

$$n^2 = 1 + \frac{2d}{\pi a}\log_e\left(\operatorname{cosec}\frac{\pi b}{2d}\right),$$

where the distances a, b, d are as shown in Fig. 1.

The new formula predicts a value of n which is observed within experimental accuracy, whereas the formula given by Kock gave a value 18 per cent too low.

It is hoped to publish a fuller account of this work elsewhere.

This communication is published by permission of the Chief Scientist, Ministry of Supply.

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Radar Research and Development Establishment,
Malvern, Worcs.

Jan. 24.

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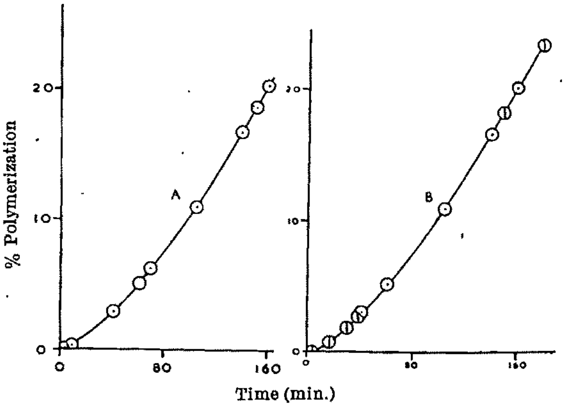
A New Catalytic Effect in Vinyl Polymerizations

In his experiments on the polymerization of vinyl chloride catalysed by benzoyl peroxide, Prat[1] observed that the rate of polymerization increased throughout the first 40 per cent of reaction. This acceleration he suggested might be either due to the gradual attainment of a steady state, consequent upon the existence of long-lived radicals, as suggested by Dostal and Mark[2], or alternatively to consecutive initiation reactions, as put forward by Cuthbertson, Gee and Rideal[3] to interpret a similar phenomenon in the case of vinyl acetate. This phenomenon in the case of vinyl acetate was later shown[4] to have been caused by the presence of impurities in the monomer.

Now the polymer which separates from liquid monomeric vinyl chloride is insoluble in the monomer. It is, therefore, possible to use a sealed dilatometer to give an accurate measure of the rate of polymerization. Such dilatometers containing accurately measured quantities of the benzoyl peroxide catalyst were filled with highly purified monomer by distillation in a high-vacuum apparatus, and sealed off. The results of Prat were confirmed: if the monomer had been insufficiently purified there was an induction period of up to several hours depending on the amount of catalyst added, during which absolutely no reaction could be observed, followed by a period of acceleration lasting for the first 40 per cent of reaction. Repeated purification (in particular from acetylene) reduced and finally removed completely the period of induction, but had no effect on the period of acceleration or the rate of the reaction.

In order to prove that this acceleration of the reaction in the case of vinyl chloride is a true kinetic effect and independent of impurities which are removed as the reaction proceeds, the following experiment was devised. Some purified vinyl chloride was polymerized to an extent of about 20 per cent conversion, in the presence of 1·04 mol. per cent benzoyl peroxide at 47° C.; the unchanged monomer was then distilled under vacuum into a second dilatometer which contained an amount of benzoyl peroxide such that its concentration in the new solution was equal to that in the original; the polymerization in the second dilatometer was then followed at 47° C.



Polymerization of vinyl chloride, catalysed by 1·04 mol. per cent benzoyl peroxide at 47° C. ⊘, original monomer; ⦶, unchanged monomer

In the accompanying graph, curve *A* represents the course of the first polymerization, and curve *B* that of the unchanged monomer. It is seen, on plotting the results from curve *A* on curve *B*, that both polymerizations proceed in an identical manner. It was then found that if vinyl chloride is polymerized to about 20 per cent polymerization, the unchanged monomer removed, and an equal quantity of fresh monomer added, the continued polymerization proceeds at the accelerated rate. This evidence makes clear that the phenomenon of acceleration is not caused by impurities which retard the rate initially, and indicates the conclusion that the polymerization is in some way catalysed by the precipitated polymer.

In confirmation of this, we have found that when polyvinyl chloride is added to vinyl chloride containing 0·5 mol. per cent benzoyl peroxide, and the mixture polymerized at 47° C., the rate of polymerization increases with the amount of polymer added; but in the absence of benzoyl peroxide no polymerization is observed even when large amounts of polyvinyl chloride are added. Further, if a solvent for the polymer, such as dibutylphthalate or tetrahydrofuran, is added to vinyl chloride catalysed by benzoyl peroxide at 47° C., the polymerization proceeds in the homogeneous phase at a constant rate throughout the early stages of the reaction, without any indication of the acceleration observed when the polymer is precipitated.

The conditions for polyvinyl chloride to exert a catalytic effect are therefore: (*a*) that it is present in an undissolved state; and (*b*) that benzoyl peroxide, or some other source of reactive free radicals, is also present in the system. It is suggested that this co-catalytic effect is due to a gradual increase in the total number of active centres as the polymer accumulates in the system. The additional centres are believed to be derived by a chain transfer reaction between free radicals and conglomerates of polymer, thus producing immobile radicals in the surface of the polymer which are largely free from the process of self-neutralization which occurs in the liquid phase. The number of these radicals will be proportional to the surface area of the polymer and also to the number of mobile radicals present, while the latter will depend upon the concentration of the catalyst. As the reaction proceeds there will therefore be an increase in the number of radicals present and consequently an increase in reaction-rate.

It is well known that 'polymer begets polymer'. For example, with vinyl chloride it has been found in technical operation that if a small amount of polymer be formed at a bend or constriction of a pipe conveying the liquid monomer under pressure, this will grow in course of time, often with serious results. Upon the above ideas it is easy to see that, even in the absence of catalyst, adventitious centres in the monomer can react, by transfer with the polymer as they flow past, to produce an active surface, which will cause the initial seed to grow continuously though slowly until the pipe is blocked.

A detailed kinetic analysis has been made, and this, together with full experimental results, will appear elsewhere.

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R. G. W. Norrish

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Jan. 4.

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Photo-chemical Activity of Paint Pigments

Recent experience has shown that certain grades of zinc oxide of local manufacture markedly accelerated the initiation of chalking in paint films. In the course of an investigation into these differences, it was observed that they corresponded to differences in the fluorescent behaviour of the zinc oxides when irradiated with ultra-violet light. The zinc oxides (Series *A*, three samples from two manufacturers), prepared by burning zinc vapour in air (French process), showed no visible fluorescence at room temperature and markedly accelerated the initiation of chalking, as compared to the zinc oxides (Series *B*, four grades from three manufacturers) prepared by burning zinc vapour in air containing reducing gases (as in the American process), which showed a strong yellow fluorescence.

This result is in apparent conflict with some statements made in the literature[1], but a comparative test for fluorescence using an 'Osira' lamp has provided a useful means of selecting non-chalking grades of zinc oxide available in Australia.

A distinct difference in the photo-chemical activities of (*A*) and (*B*) was also noted. An aqueous suspension of (*A*), after irradiation for a short period with an 'Osira' lamp, was found to contain hydrogen peroxide[2], liberating iodine from potassium iodide solution, decolorizing permanganate solution and giving a yellow colour with titanium sulphate solution. Longer irradiation by direct sunlight also caused formation of hydrogen peroxide. A suspension of (*B*) treated in the same way gave no reaction for peroxide.

The major contributing factor in the different performances of paints containing (*A*) and paints containing (*B*) must be that in the former the high-energy portion of the solar radiation is utilized as photo-chemical energy, whereas in the latter it is dissipated as lower-energy radiation[3]. From (*A*) the energy may be transferred directly to the unsaturated fatty oil, providing the energy required for the removal of hydrogen from the α-methylenic group, this being the initial step of the oxidation suggested by Farmer[4]. From the above evidence, however, it appears to be more likely that transfer of energy to oxygen takes place followed by entrance of molecular oxygen at the double bond, as suggested by Hilditch[5]. The production of hydrogen peroxide in the presence of water also provides an explanation for the observed acceleration of chalking under moist conditions.

It is hoped that a detailed study of the fluorescence spectra and their dependence on environment for a number of differently prepared zinc oxides and other pigments will provide further information about their influence on the photo-chemical oxidation of paint vehicles.

G. Winter

General Chemistry Section,
Defence Research Laboratories,
Melbourne. Aug. 19.

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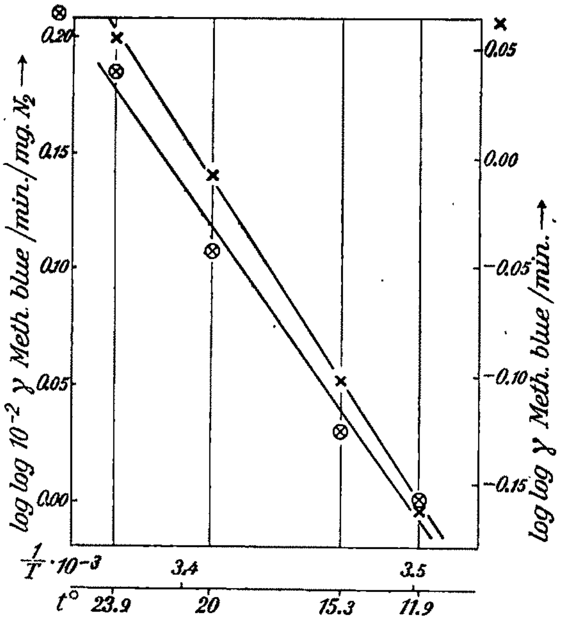
Thermal Activation of the Dehydrogenase Systems of the Unfertilized and Fertilized Eggs of the Sea Urchin, *Paracentrotus lividus*

Runnström[1] and Örström[2] were the first to try to compare the dehydrogenase activity in the sea urchin egg (*Paracentrotus lividus*) before and after fertilization by means of methylene blue reduction experiments. They could not reveal any difference. However, Ballantine[3], carrying out similar experiments, was able to demonstrate a rise in the rate of methylene blue reduction in the sea urchin *Arbacia punctulata* ranging from 2·2 to 3·7 times. In 1939 Miss Inger Stordal, in preliminary experiments in collaboration with one of us (P. E. L.), proved the methylene blue reduction by fertilized eggs to have a higher temperature coefficient than that of the unfertilized egg. The completion of these experiments was postponed because of the outbreak of war.

Our experiments carried out at Roscoff (France), at a temperature of about 12°, 16°, 20° and 24° C., confirm this result; thus the difference in reduction-rate is nil, or comparatively small, at 12°, but rather considerable at 24° C. This is due to the different slopes of the temperature curves, and also to the different forms of the curves, those of the fertilized eggs being more bent than those of the unfertilized ones. Further analyses of these data reveal that, for the unfertilized eggs, the logarithm of the reduction-rate plotted against $1/T$ forms a straight line; but for fertilized eggs there is still a bent curve. If, however, the logarithm of the reduction-rate of the fertilized eggs once iterated is plotted against $1/T$, an approximately straight line is obtained (see graph). Thus the thermal activation seems to follow the Arrhenius equation in the unfertilized egg, whereas a more complicated relationship holds for the fertilized egg.



The rate of methylene blue reduction is referred to 1 mgm. of egg nitrogen (except in the experiments with egg extract). ⊕, fertilized eggs; ×, egg extract + coenzyme I + glucose-6-phosphate

It is well known from Warburg[4], Runnström[5] and others that the respiration of unfertilized sea urchin eggs slowly rises, this process being suppressed by agents inhibiting the respiration[5]. As in the experiments described, the unfertilized eggs were handled for about two hours before the performance of the measurement; during washing and mechanical removal of the jelly coats, their respiratory state was supposed not to correspond to the original one typical of the egg as expelled from the ovaries. Thus the ovaries were allowed to discharge into sea-water of 10° C., at which temperature the eggs were kept during the preparations. In such cooled unfertilized eggs the thermal activation is of still another type, the rate of methylene blue reduction giving a straight line when plotted against $1/T$.

We have thus observed three different types of thermal activation of the dehydrogenase activity in eggs: (1) that of the cooled, unfertilized eggs, representing the state of those freshly laid; (2) that of the uncooled eggs, representing the state after some hours in sea water; (3) that of the fertilized egg.

The difference in thermal activation of the fertilized and the unfertilized (cooled) eggs disappears when the eggs are crushed by adding distilled water, the same type of curve being obtained as in the case of cooled unfertilized eggs. We are unable to suggest any theoretical explanation for this type of curve. When, however, coenzyme I and glucose-6-phosphate are added to an almost clear egg extract, obtained by centrifuging crushed eggs, the very high rate of methylene blue reduction resulting shows a thermal activation identical with that of the fertilized living egg (see graph).

The dependence of the rate of the methylene blue reduction in an exponential way on the rate of another reaction, for example, a phosphorylation—the thermal activation of which follows the Arrhenius equation—may possibly be the basis of this iterated logarithmic function. Such a coupling between oxido-reduction processes and phosphorylations is well known to exist, for example, during the exponential induction phase of artificial fermenting systems. According to Lindberg and Ernster[6], the oxidation of glucose in homogenized sea urchin eggs is coupled with the esterification of phosphate.

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Effect of Necrosin on Spontaneous Tumours in Swiss Mice

I HAVE demonstrated within the last decade the presence, in inflammatory exudates, of various substances with definite biochemical properties. These substances are at present relatively crude, and it is hoped they will be purified further. Analysis of the exudate reveals some substances, which appear to be polypeptide in some cases and proteins in others, capable of reproducing the same effect as the whole exudate. Blood serum fails to show the presence of these substances unless there is a concomitant inflammation. This would indicate that presumably these substances penetrate from the site of injury into the circulation, for in the early stage of an inflammation they are absent from the blood, whereas they can already be detected at the site of an acute inflammation[1].

One of these substances is concerned with the basic pattern of injury in inflammation. It is closely associated with the euglobulin fraction, particularly of acid exudates. I have given the term 'necrosin'[2] to this substance. Its introduction into normal tissue induces severe injury with all the signs of an acute inflammation. Other protein fractions of exudative material fail to produce a similar picture.

Necrosin is found in the euglobulin fraction of exudates, freed in turn of insoluble material in the presence of electrolytes. Ludford[3] and Duran-Reynals[4] have shown that dyes or proteins are localized into tumours. Duran-Reynals ascribes this localization to the greater permeability of capillary vessels in a tumour than is found in normal circumstances[4]. For this reason necrosin, as a substance associated with a protein fraction of exudates, was injected into about two hundred Swiss mice with spontaneous tumours. The tumour is a mammary one and it is very vascular. The subcutaneous injections of the material were always made at a distance from the tumour. The amount of necrosin administered in the fluid state varied from an equivalent dose of 0·2 μgm. of necrosin to 1,748 μgm. of lyophilized necrosin. After one or several injections, the material induced hæmorrhagic or other forms of necrosis, such as a mucoid-like yellowish fluid, or rarely a caseous-like central necrosis, in the tumour. Hæmorrhagic necrosis was also found to occur in some of the metastatic foci of the lung. A certain amount of necrosis in these areas appeared as early as one hour after the administration of necrosin. This toxic substance concomitantly causes hepatic injury in the form of vacuolation of the cytoplasm of the liver cells. Sometimes one encounters various forms of leucocytic infiltration in the liver. Whether or not the hepatic injury is the cause of the death of the animal is not yet clear. At times, injury to the kidney is also seen in the form of foci of leucocytes. This and other factors are at present under investigation, for to date there is no evidence that the span of life is prolonged with necrosin treatment. Nevertheless, the effect is specific and does not occur with other protein fractions, such as the euglobulin of normal blood serum or with papain. Further work is being conducted with different strains of mice; methods are also being devised to counteract the toxic effect of necrosin on the liver.

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Para-Aminobenzoic Acid in Human Leukaemias

BICHEL[1], and later Zarafonetis and co-workers[2], recorded interesting data concerning the effect of *para*-aminobenzoic acid in leukæmias.

In an attempt to confirm Bichel's findings, we investigated the effect of a single intravenous injection of *p*-aminobenzoic acid on patients with leukæmias, and on controls; we administered the sodium salt in 3–5 per cent solution. The intravenous infusions were given for 10–21 minutes. In each case the total amount was 5 gm. The *p*-aminobenzoic acid serum levels (maximum) ranged from 18 to 31 mgm. per cent.

We made nine trials in seven patients with leukæmias and six trials in six persons not suffering from this group of diseases. The patients tested could be grouped as follows according to clinical condition: three chronic myelocytic leukæmic myeloses, one subchronic promyelocytic–myelocytic leukæmic myelosis, one chronic subleukæmic lymphoid leukosis, one chronic aleukæmic lymphoid leukosis, and one acute paraleukoblastic form. The group free from leukæmia included one healthy individual, one with Hodgkin's disease, one with Vaquez–Osler disease, one with cirrhosis hepatis, one with Besnier–Boeck–Schaumann disease, and one case of rheumatic fever.

We found that all four patients with myelocytic leukæmia developed a fever response, with chill and shivering, which occurred between one and four hours after the injection had been given. The fever might exceed 39° C. (102° F.), and showed no close relationship to the *p*-aminobenzoic acid blood-level or to the speed of the infusion. The two patients with lymphoid leukæmias and the case of acute paraleukoblastic form did not show this reaction; nor did the non-leukæmic controls.

The total and differential leucocyte counts, and the cells of the spleen (the latter were examined in only two cases), did not show constant significant deviations. It was remarkable that in our leukæmic patients the renal elimination of *p*-aminobenzoic acid occurred in the same manner as we have described for healthy individuals.

Our evidence to date indicates that the phenomenon here noted cannot be obtained if the leucocyte-producing system is under the influence of a completely developed urethane effect[3].

We suggest a humoral basis for the shivering and fever, and conclude that it may be caused by some substance liberated from the leukæmic leucocytes as a result of the administration of *p*-aminobenzoic acid. To confirm this view, experiments are in progress with whole blood, with serum, and with leucocytes, etc., inoculated into guinea pigs.

We hope to publish the results of these tests, and also of the investigation reported above, in detail later elsewhere.

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* Working with a grant from the Lady Tata Memorial Trust.

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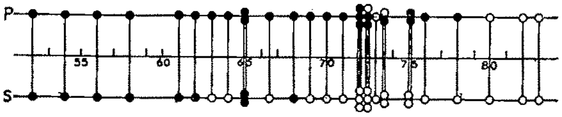
Failure of Transmission of Motor and Sensory Nerve Impulses after Nerve Section

HITHERTO the time at which failure of transmission of nerve impulses occurs following section of the nerve trunk has been determined in mixed nerves only. In the popliteal and sciatic nerve of the cat it was found to occur after about three and four days respectively[1,2]. Erlanger and Schoepfle[3] found degeneration in the phrenic nerve to be complete after about four days.

It is possible that failure of impulse transmission after nerve section sets in at different times in different groups of nerve fibres. Indeed, Moenkeberg and Bethe[4] had shown histologically that degeneration proceeds more quickly in sensory than in motor nerve fibres, and von Muralt[5] as well as Rosenblueth and Dempsey[6] consider that the thick nerve fibres with a rapid conduction-rate degenerate earlier than the thin, slowly conducting ones. Rosenblueth and Dempsey found that in a few nerves the *A* spike had already considerably decreased at a time at which the *C* spike was still normal. They supported their conclusion also by the fact that the rate of conduction increased in the degenerating nerves when the stimulating electrode was moved peripherally towards the recording electrode, suggesting that degeneration followed a centrifugal course. However, Erlanger and Schoepfle showed that failure of nerve conduction does not proceed centrifugally, but that conduction fails at scattered loci increasing in frequency peripherally.

We have re-investigated the question by using for comparison the sural and peroneal nerve of the rabbit. The sural nerve, apart from its sympathetic contribution, is a purely sensory nerve; the peroneal nerve, apart from its sympathetic contribution, contains afferent and efferent fibres from and to skeletal muscles. The nerves were excised at different times after section and placed in a thermostat on platinum electrodes. The temperature of the chamber varied from 36° to 38° C., but was approximately constant for any given set of observations. The electrical responses of the nerves were recorded by a cathode ray oscillograph (highest sensitivity 80 microvolts/cm.), the distance between stimulating and recording electrodes being 2–4 cm.

The time at which the nerves failed to conduct impulses after nerve section varied considerably in different animals, and was to some extent dependent on the age of the animal. Therefore the comparison was always made for the nerves of the same animal, and one- to two-year-old rabbits were used. From the accompanying diagram it will be seen that in the same animal impulse conduction failed about 10 hr. earlier in the sural than in the peroneal nerve. In the sural nerve, it failed after about 63–68 hr.; in the peroneal, after about 72–80 hr.



Times in hours at which the excitability of the peroneal (P) and the sural (S) nerves were tested following nerve section. Both nerves are taken from the same animal. Filled circles: action potential could be recorded; empty circles: no action potentials could be recorded when stimulating the nerve

Further evidence in favour of differences in the time course of degeneration in different groups of nerve fibres was provided by the electrical responses of the degenerating nerves. The height of the spike potential decreased with increasing time of degeneration. Moreover, in the sural nerve two spikes could be observed at the beginning, but one only at later stages of degeneration. The nerve fibres thus appear to cease functioning successively and according to a certain order.

We may conclude that the sensory fibres from the skin degenerate earlier than the afferent and efferent fibres in motor nerves. The thickness of the myelin sheath may be the main factor in determining the time course of degeneration after nerve section. These findings may be useful when classifying nerve fibres according to their morphological and physiological characteristics.

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Determination of Proteins in Cerebro-Spinal Fluid

It appears from conversations I have had with medical officers concerned with trypanosomiasis that there is a need for a reliable and rapid method of estimating the protein content of cerebro-spinal fluid. Existing methods that rely either on the estimation of opalescence or volume of precipitate[1,2], when a protein-precipitant is added to cerebro-spinal fluid, are open to a number of obvious objections.

I have found that the xanthoproteic reaction can be made quantitative and that an easily reproducible artificial standard can be used. The method is as follows:

Reagents. $M/3$ zinc sulphate solution; $N/2$ sodium hydroxide solution; 6 N nitric acid solution; 10 N sodium hydroxide solution. *Procedure.* Dilute 2·0 ml. of cerebro-spinal fluid with 4 ml. water in a centrifuge tube. Add 0·1 ml. $M/3$ zinc sulphate; mix. Add 0·1 ml. $N/2$ sodium hydroxide; mix and centrifuge. Decant the supernatant liquid and drain well. Add 3 ml. 6 N nitric acid and place the tube in boiling water for 15 min.; cool. Add 2 ml. 10 N sodium hydroxide. Cool and dilute to 6·0 ml. Compare the colour of the solution so produced with a suitable dilution of an accurately standardized solution of potassium dichromate.

The protein content of the cerebro-spinal fluid is given by: mgm. per cent of protein $= T/S \times C \times 1{\cdot}6$, when T/S is the ratio of colour intensity produced by the above method to that of the standard; C is concentration of standard dichromate solution in mgm. per cent of $K_2Cr_2O_7$.

The zinc hydroxide precipitate packs down well, even in a small hand-operated centrifuge, so that the method can be used in field stations. Alternatively, the zinc precipitate may be collected on a sintered-glass filter and afterwards washed through into a fresh tube with 3 ml. of hot 6 N nitric acid divided into small portions. 'Globulin' may be determined by adding to cerebro-spinal fluid an equal volume of saturated ammonium sulphate solution (adjusted to pH 5·4 with acetic acid) and separating the precipitate. The test may then be applied to this precipitate, giving 'globulin'. 'Albumin' can be calculated by difference from total protein.

The zinc hydroxide precipitation is only necessary when there is a possibility of the presence in the cerebro-spinal fluid of compounds, other than proteins, containing aromatic nuclei, for example, tryparsamide, sulphanilamide or similar drugs. If such compounds are known to be absent, the test may be applied directly by adding 1 ml. of concentrated nitric acid (s.g. 1·42) to 2·0 ml. of cerebro-spinal fluid and proceeding at once with the 15-min. heating in boiling water. The subsequent steps are the same as already described.

The dichromate solution is not of exactly the same colour shade as that produced in the test but is close enough to it to be almost indistinguishable in a Du Boscq or 'wedge' type of colorimeter when the protein in the cerebro-spinal fluid is less than 40 mgm. per cent, which is the most important range. A phenol solution may be used as a colour standard and gives a closer approximation to the shade of the test colour when put through the same process; but it was considered that for field use a hollow wedge colorimeter with dichromate solution in the wedge was the easier with which to work. It was interesting to note that when a Spekker photo-electric absorptiometer was used with Chance 0B1 filters, the protein values obtained with the dichromate standard were only slightly greater (less than 5 per cent) than those determined visually in a colorimeter, using the same standard.

A micro-Kjeldahl method, adapted from a combination of the methods of King, Haslewood and Delory[3,4], and of Miller and Miller[5], was applied to individual samples of cerebro-spinal fluid and also to bulked samples. The figures for protein concentrations thus obtained were used to calibrate the dichromate standard. Unfortunately, owing to pressure of other work, it was not possible to devote as much time to this work as was desirable. The factor (1·6) relating dichromate colour to xanthoproteic colour cannot, therefore, be assumed to be absolutely accurate, but is not likely to be far wrong. In only a small proportion of the samples did the factor differ greatly from 1·6. This seems to justify the assumption that, although the colour developed in the test is dependent on the presence of phenyl groups in the protein, the proportion of these is substantially constant in the proteins of the cerebro-spinal fluids tested.

The factor 6·25 was used to convert the Kjeldahl nitrogen figures into protein figures. This assumption can only be checked by isolating and purifying the protein from cerebro-spinal fluid.

It is hoped to check and undertake a more detailed study of the method when an opportunity arises. However, as I can find no previous reference to a similar method, it appears desirable that these preliminary findings be made known so that other workers might be able to examine the method.

I wish to express my thanks to Dr. G. F. Saunders for indispensable help in obtaining samples of cerebro-spinal fluid and for his interest and constructive criticism, to Dr. G. Tooth for first bringing to my notice the need for a simple method of estimating proteins, and to Dr. J. G. S. Turner, director of Medical Services, Gold Coast, for permission to submit this note for publication.

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2 : 3 Dimercaptopropanol (B.A.L.) and Methyl Iodide Intoxication

LEWIS[1] has reported the inhibition of SH enzymes by methyl bromide. It is therefore of interest to note that we have found a similar effect with methyl iodide.

Kerateine was prepared from sheep's wool by the method of Goddard and Michaelis[2]. A 0·2 per cent solution of kerateine in 0·1 *M* sodium carbonate was exposed to an atmosphere containing 10 mgm. of methyl iodide per litre, and a progressive decrease in the colour given with sodium nitroprusside was noted.

A suspension (0·5 per cent) of urease was made up (1) in distilled water, (2) in 0·98 *N* methyl iodide, and (3) in 0·98 *N* methyl alcohol/potassium iodide mixture. After standing four hours, 15 ml. of the urea/phosphate mixture of Sumner[3] was added to each. The mixtures were allowed to stand at room temperature, 21° C., and at intervals samples were withdrawn and ammonia determined with Nessler's reagent. An inhibition of about 50 per cent was found with the methyl iodide mixture, whereas the methyl alcohol/potassium iodide mixture was as active as the control, showing that the inhibition is due to the methyl iodide molecule as a whole.

Inhibition of urease by methyl iodide

Mixture	Ammonia (mgm./ml. reaction mixture)		
	At 20 min.	At 40 min.	At 60 min.
1	2·1	3·75	5·8
2	1·25	1·75	2·25
3	1·9	3·2	6·0

These results led us to try the effect of B.A.L. in methyl iodide poisoning in mice. A dose of 50 mgm. B.A.L. per kilo body-weight administered before exposure gives complete protection from a concentration which would otherwise be lethal for all the animals in a group; but B.A.L. given immediately after exposure has only slightly prolonged the time of survival.

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Estimation of Digestibility of Grazed Pasture from Fæces Nitrogen

IN a recent communication in *Nature*, Raymond[1] has proposed a method of estimating the nitrogen content and the related nutritive value of pasture herbage consumed by grazing sheep from the nitrogen content of the resulting fæces. While this relationship should prove very useful in sheep nutrition studies, it appears likely, on the basis of work carried out at this Station[2,3], that a still more precise expression of the nutritive value of the herbage can be obtained from the data used by Raymond. It is the purpose of this communication to describe how the organic matter digestibility of pasture can be calculated from the nitrogen content of the fæces.

As a result of an analysis of the data from digestibility trials carried out at widely dispersed centres in New Zealand, a hypothesis was set up to the effect that the nitrogen excreted in sheep fæces per unit intake of pasture organic matter is constant. Knowing the value of this constant (C), and the concentration of nitrogen in the ash-free fæces (n per cent), the amount of organic matter in the herbage giving rise to 100 gm. of fæces organic matter will then be $100n/C$ and the digestibility will be given by

$$D = \left[\frac{\frac{100n}{C} - 100}{\frac{100n}{C}}\right] \times 100 = 100\left[1 - \frac{C}{n}\right]. \qquad (1)$$

The value of C calculated from the data under analysis was 0·83 ± 0·102 gm. nitrogen per 100 gm. of pasture organic matter consumed. These data were collected from fifty-two digestibility trials[3] covering pastures ranging in organic matter digestibility from 50 to 85 per cent and in protein content from 10 to 36 per cent (dry matter basis).

The accuracy of equation (1) for evaluating D is a function of n and of the standard deviation, s, of the constant C. Thus, if D and D_1 are calculated by using two values for the constant (C and C_1) differing by the standard deviation s, then

$$D = 100\left[1 - \frac{C}{n}\right], \quad D_1 = 100\left[1 - \frac{C_1}{n}\right],$$

and
$$D - D_1 \doteq 100\left[\frac{C_1 - C}{n}\right] = \frac{100s}{n}. \qquad (2)$$

A convenient means of assessing the accuracy of the proposed method of estimating digestibility is provided by equation (2), which shows that the greatest accuracy is obtainable at the highest concentration of fæcal nitrogen. When equation (1) was applied to the data from the digestibility trials mentioned above, it was found to yield results for D the agreement of which with those calculated from measurements of feed ingested and fæces voided were well within the limits of accuracy predicted by equation (2), provided n was not less than 3 per cent (equivalent to about 15 per cent of protein in the pasture consumed). When n was less than 3 per cent, however, the accuracy was not as high as equation (2) predicted, and the results were biased in such a direction as to indicate that $C = 0{\cdot}83$ was too high a value for the low-protein pastures.

Mitchell[4], from an analysis of data from pasture digestibility trials with sheep, has shown that the small variations of protein excreted in fæces per 100 gm. of pasture dry matter consumed are positively correlated with the protein content of the pasture. This provides an explanation of the bias noted above, and suggests that greater accuracy could be achieved in the calculation of D if some provision could be made for the nitrogen content of the pastures. The number of trials on low-protein pasture, however, was considered too small to warrant an attempt being made to carry this out.

In view of these considerations, the investigation was extended to include as much material from published work as could be obtained locally. From the results of one hundred and one digestibility trials[5], plus the data from the fifty-two trials already discussed, a value for C was calculated. This proved to be $0{\cdot}76 \pm 0{\cdot}113$. The pastures covered in this investigation were located in England, United States, South Africa and New Zealand. They ranged in organic matter digestibility from 48 to 85 per cent and in protein content from 5 to 36 per cent.

Further inspection of the data indicated that they could be divided conveniently into two groups: (A), 103 trials, in which the protein content of the pasture was 15 per cent or more; (B), 50 trials, in which the protein content of the pasture was less than 15 per cent. On this basis, C was found to be $0{\cdot}80 \pm 0{\cdot}081$ for group A and $0{\cdot}67 \pm 0{\cdot}120$ for B.

The results of the foregoing discussion suggest that the method proposed of calculating the digestibility of pasture by sheep is of fairly wide applicability both in terms of pasture types and geographical location. The most important factor contributing to the different values of C obtained appears to be the nitrogen content of the pastures, and although the differences between these values are not statistically significant, real differences may nevertheless exist. Some advantages might, therefore, be gained by using values of C_1 determined by the range of the nitrogen content to be expected in a pasture herbage under investigation.

From points made in this communication, the graph presented by Raymond may now be interpreted in terms of organic matter digestibility. Using $C = 0{\cdot}76$, the mean value obtained for all pastures studied, the nitrogen scale of his graph may be converted to a digestibility scale with a range from 69·6 to 81·0 per cent.

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A New Theory of Phyllotaxis

A REVIEW of my book "La Théorie des Hélices foliaires multiples", which appeared in *Nature* of November 20, p. 798, does not give an objective view of its subject-matter.

In my opinion, the fundamental character of a law being its generality, a common phyllotaxic law should at least apply to all the angiosperms. Now, the numerous phyllotaxic theories, all of which rely on the idea of divergence, cannot be verified except in particular cases or in ideal examples where the mind corrects and adjusts Nature where it is judged imperfect. The leaf considered as a point, or the stem considered as a cylinder, are typical examples of this idealization.

Taking as my starting point cases where it is impossible to find constant divergence along the line which, going from leaf to leaf, forms a genetic spiral—cases where it is only possible to trace a spiral because one wishes to do so and so makes corrections, with a pretence of metatopy, in the position of almost half the leaf points—I have discovered a law concerning the position of leaves on stems which has not previously been recognized. It is based on the existence of series of leaves called leaf-helices. The plotting of these lines is not arbitrary, since the successive leaves in a leaf-helix are contiguous so far as the segments by which they extend along the stem are concerned. The leaf-helices are usually two in the dicotyledons, but vary in number (frequently three, sometimes one) in the case of the monocotyledons.

This interpretation offers a solution to numerous problems of morphology. It unifies the arrangement of leaves in spirals or in whorls, and explains the frequent change from one to the other on the same plant. It unifies the most diverse leaf arrangements and explains the stems of palms as well as cacti. It offers a new explanation of teratological phenomena present in leaf-bearing stems, and, in particular, fasciation. It offers a hypothesis on the nature of the growing-point; but I have also shown that experiment alone can demonstrate the value of the theory.

It is not reasonable of the reviewer to reduce the book to a hypothesis on the physiological constituents of the growing-point. Moreover, the way in which he has substituted, in the title and the matter of his text, the idea of leaf formation for the idea of phyllotaxis—which implies only the arrangement of leaves on stems—in order to criticize the absence of studies on growing-points, betrays confusion on his part. Moreover, readers will find that the points of view of the reviewer have been met in an article called "Hélices foliaires, point végétatif et stèle chez les Dicotylédones" which appeared in the *Revue générale de Botanique* (**54**, 49; 1947).

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PROF. PLANTEFOL'S chief criticism of my review seems to be that I have taken as the most important feature of his book the conclusions concerning leaf formation at the apex which he has based on his observations of the relative positions of leaves or of their scars on mature stems. He claims that even apart from these conclusions his observations have value and lead to a law which solves various morphological problems. But his book and also his recent paper make it appear throughout that this law or theory, the theory of the foliar helices, was indeed intended as a causal theory of leaf formation. Thus, for example, on p. 195 of his book, in discussing *Lilium candidum*, he refers to the three foliar helices which he finds as being a "système fait de l'activité de trois centres générateurs de feuilles, entités douées chacune de propriétés mitotiques particulières, qui se transmettent de proche en proche suivant la ligne que trace l'hélice". I maintain, therefore, that I was right in regarding his theory of the foliar helices, supplemented by his theory of the apical organiser, as being essentially a causal theory of leaf formation at the apex, though based on observations made on mature parts of shoots. If he now proposes to regard this theory as being essentially only a descriptive rule, then how can such a descriptive rule concerning the positions of leaves on mature stems explain anything, or lead to anything more than a classification of facts ?

My criticism of the theory that leaves are formed along the foliar helices was that these helices are at best only one set arbitrarily selected from the two well-known sets of intersecting parastichies, or paths along which the bases of leaves or other lateral members are in contact. Prof. Plantefol claims that his helices are not arbitrary, since the bases of the lateral members are in contact along them. But so also are they in contact along the helices or parastichies of the other set which crosses the first set, as can easily be seen on a pine cone, for example; and there are no valid grounds for preferring the one set to the other. The same can be seen in the figures of bud sections in his recent paper, in which he marks the parastichies of one set as being his foliar helices, but ignores those winding round the apex in the opposite direction. Also there is no rule that the parastichies of either set are only two in Dicotyledons, though the number two is rather common for the reasons given before. So the theory is another theory of leaf formation along lines continuing parastichies into the apex, something like that of Church[1], but with the disadvantage that it is based on an arbitrary selection of parastichies. In addition, all such theories are in conflict with evidence now available from experiments on stem apices[2] which reveal no *leaf-forming* influences extending into the stem apex from below or obliquely below, but only effects *delaying* leaf-formation which are exerted by the young leaves just below the apex. The only indications of leaf-forming influences from below are at present those obtained by Weisse[3] in various ridged succulents: and those influences do not follow the parastichies but the nearly vertical ridges.

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[1] Church, A. H., "On the Relation of Phyllotaxis to Mechanical Laws" (London, 1904).

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[3] Weisse, A., *Jb. wiss. Bot.*, **39**, 343 (1904).

Threat of Disease in Tropical Crops

THE report by a committee of pathologists of three nations which has been inquiring into swollen shoot disease of cacao (His Majesty's Stationery Office, Colonial No. 236) contains matter of interest beyond the field of inquiry. Pathologists in the past have often been inclined to consider infection in a biological vacuum. The disease organism (assisted in the case of viruses by a vector) was regarded as an agent of destruction subject to no external conditions except those which might be imposed by pathologists.

This attitude has left its mark on the present report. It asserts that, "Drought, old age, lack of canopy, and poor soils have nothing whatsoever to do with it"—the disease. This is emphatic. But it is not a conclusion derived from experiments with swollen shoot of cacao. The genetically unstandardized condition of the cacao trees in West Africa would invalidate any experimental evidence that might be available on the question. None, in fact, is adduced by the committee.

In a word, there is no reason for supposing that the committee has discovered an exception to the biological law that external (as well as internal or genetic) conditions affect to a greater or less degree the incidence of every type of pest and disease of plants and animals.

On the other hand, the genetic variable is of the first importance, and this is recognized by the committee. It points out "the development of varieties resistant to infection would be an ideal solution of the problem". But it omits this fundamental principle from its conclusions; and it has postponed the application by a dangerous misstatement: "It takes *many* years to obtain seed from a single crossing of two parents". In fact, it takes *two* years; and this time could be reduced by experimental improvement of growing conditions. Hence, the committee concludes, "This is a long term problem without any immediate practical significance". This is again emphatic. But what does it mean ? It means that in prosperity plant breeding had no immediate significance. In disaster it has no practical significance. Thus in cocoa as in all other British tropical crops (except cotton) the ideal solution, the fundamental solution, has still to be treated as a subsidiary matter of no urgency. And there is no plan for attempting it. This is the immediate and practical significance of the report on swollen shoot in cacao.

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ROYAL SOCIETY OF CANADA

ANNUAL MEETING

THE 1948 meeting of the Royal Society of Canada was held at Vancouver (June 14–16) and Victoria (June 17) in British Columbia. This was the first time in its sixty-six years of existence that the Society has met west of Winnipeg, and for a while it seemed that the serious floods of the Thompson and Fraser Rivers would force the cancellation of the sessions here reported.

A general meeting of the Society, at which new fellows were introduced, was held on the morning of June 14. Those elected to the Scientific Sections of the Society were as follows: Section 3 (chemical, mathematical, and physical sciences), John David Babbitt, Adrien Cambron, Frank Thomas Davies, Richard Norman Jones, Robert Lloyd McIntosh and George Michael Volkoff; Section 4 (geological sciences), John Fletcher Caley, Edward Darwin Kindle and John Tuzo Wilson; Section 5 (biological sciences), James Kenneth Wallace Ferguson, F. E. J. Fry, Nathaniel Hew Grace, Rene Pomerleau, Frederick Smith and Omond McKillop Solandt.

On the evening of the same day the Flavelle Medal was presented to Margaret Newton, who was for a long time associated with the Dominion Rust Research Laboratories at Winnipeg, and whose work on the fungi attacking wheat has been of such importance in Canada. The Lorne Pierce Medal was awarded to Gabrielle Roy, author of "Bonheur d'Occasion", and the Tyrrell Medal to Canon Groulx. The president of the Society, Dean W. P. Thompson, of the University of Saskatchewan, then delivered his presidential address on "Mutations". This proved to be a masterly treatment of a difficult subject, made intelligible to a general audience. The final meetings were held in Victoria on June 17.

Officers for the session 1948–9 were elected as follows: *president*, Dr. Gustave Lanctot; *vice-president*, Dr. J. A. Pearce; *honorary secretaries*, Dr. F. J. Alcock and Dr. Seraphin Marion; *honorary treasurer*, Dr. L. E. Howlett; *honorary editor*, Dr. G. W. Brown.

Section 3: *President*, Dr. J. S. Foster; *vice-president*, Dr. C. S. Beals; *secretary*, Dr. H. G. Thode.

Section 4: *President*, Dr. Victor Dolmage; *vice-president*, Dr. T. L. Tanton; *secretary*, Dr. George Hanson.

Section 5: *president*, Dr. A. H. Hutchinson; *vice-president*, Dr. T. W. M. Cameron; *secretary*, Dr. R. D. Gibbs.

In Section 3 the presidential address, delivered by Dr. E. W. R. Steacie, was on "Photosensitization", an illuminating review of processes involved in photochemical reactions. Two symposia, of interest to the whole section, were held, at the first of which, on "Chemical Kinetics", four papers were presented: "Reactions of Atomic Sodium", by Dr. D. J. LeRoy; "Halogen-Sensitized Photoreactions", by J. W. T. Spinks; "The Thermal Decomposition of Complex Molecules", by C. C. Coffin; and "The Radiation Chemistry of Aqueous Solutions", by F. H. Krenz. LeRoy studied the subsequent reactions of the free radicals invariably produced in the primary reaction between atomic sodium and various halides. Particular attention was given to the free vinyl radicals produced in the reaction of atomic sodium with vinyl chloride and vinyl bromide. When using hydrogen as a carrier for atomic sodium, spurious results may sometimes arise. Reactions due to atomic hydrogen were possible in such a system as one containing sodium hydride, hydrogen and ethane. Spinks, using spectroscopic evidence which indicated whether absorption of light by the halogen results in the formation of atoms or excited molecules, together with kinetic studies, described the mechanisms of a number of photochemical reactions sensitized by chlorine, bromine and iodine. Coffin discussed the effect of molecular structure on the activation energies, frequency factors, etc., of certain decompositions, particularly those of methylidene diacetate, peraldehyde and their homologues decomposing in the gaseous state at temperatures low enough to ensure the absence of free radical complications. F. H. Krenz described work to determine the 'indirect effect' on biological systems of the hydrogen atoms and hydroxyl radicals produced in aqueous solutions subjected to radiation. The effect was studied through the properties of irradiated water. Evidence was obtained for the production of long-lived activity in irradiated water, which may be due to electronically excited 'polymers' of water, and which may account for the efficiency of the 'indirect effect'.

At the second symposium, on "Nuclear Physics", papers were presented as follows: "Experiments with Neutrons", by Dr. B. W. Sargent; "The $4n+1$ Radioactive Series", by E. P. Hincks; "Variations in Isotope Content of Light Elements", by H. G. Thode; "Progress Reports on McGill Cyclotron Project", by J. S. Foster; "Nuclear Physics Programme of the University of British Columbia", by G. M. Shrum. Sargent discussed determinations of the half-life of photoneutrons, measured after shutting down a low-powered atomic pile, following different lengths of activation. Instrumentation had to be improved to allow for the large range of intensity encountered. Thode described experiments using a mass spectrometer to measure the isotopic constitution of boron obtained from various mineral deposits in the earth's crust. This investigation involved the use of boron trifluoride gas prepared from boric acid. Both BF_2^+ and B^+ ions were considered in the determination of the boron-11/boron-10 ratios. Automatic recording equipment gave the relative values of these ratios for the different samples with a precision of ± 0·1 per cent and an absolute accuracy of ± 0·5 per cent or better. The ratio was found to vary from 4·27 to 4·42, depending on the source of the boron. Corresponding variations in the chemical atomic weights have been calculated using the latest mass data for the isotopes. For the remainder of the programme Section 3 was divided into subsections, and seven papers were given in the subsection on chemistry, twenty-eight papers in general physics and mathematics, and fifteen in astrophysics and geophysics.

In Section 4 the presidential address, delivered by Dr. F. J. Alcock, was on "Problems of New Brunswick Geology". The rocks of New Brunswick range in age from Precambrian to Triassic. Deformation and intrusion took place in the Precambrian, the Devonian and the Carboniferous ages; and the Triassic rocks have been extensively faulted. Volcanism was recurrent. Detailed study in local areas has established the main facts of the geological story of the Province, but there are many places where the absence of fossils, the metamorphosed character of the rocks and the predominance of volcanic members present problems of correlation. The paper gives the conclusions reached by the author as a result of field work carried out in that region over the last quarter of a century, and is a most useful summary for all who are interested in the Appalachian geology of eastern Canada.

Thirteen papers were presented, and a lively discussion on the origin of granites followed the presentation of a paper entitled "Back to Logan" by H. C. Cooke, in which he briefly reviewed the development of theories of granitization and concluded, in harmony with an early interpretation by Sir William E. Logan, that many bodies in granite in Canada have been thus formed. Problems in the interpretation of age relationships of granites were dealt with in "Extent of Proterozoic Granite Intrusions in the Western Part of the Canadian Shield", by J. F. Henderson, and "The Relation of the Granite and the Seine Series at East Shoal Lake, Ontario", by E. L. Bruce and J. S. Ross. "Recent Data on the Nature and Origin of some Iron Deposits in the Canadian Shield", by E. S. Moore, gave information about Algoma and Labrador, where exploration for iron ore is in progress. "An Occurrence of Boron Minerals at Silver Harbor, Ontario", by T. L. Tanton and Eugene Poitevin, described a vein in which danburite has been found for the first time in Canada. "Radioactive Nodules in Sediments of the Sibley Series, Nipigon, Ontario", by T. L. Tanton, reported the results of a recent study of nodules in the red beds of the Sibley series, which were observed to be lithologically similar to uranium-bearing nodules in the Permian red beds of Devon, England. "Eoeponidella", by R. T. D. Wickenden, described a new genus of foraminifera. A paper of general interest to the members of the Section was "The Geological History of Greater Vancouver", by M. Y. Williams.

Section 5 had a very crowded programme with more than fifty papers listed, and for some sessions the Section split into separate botany, zoology and medical sciences subsections. The address of the president, Dr. E. Gordon Young, of Dalhousie University, was entitled "Canadian Dietary Patterns, 1937–1947", and constituted a survey of work on diets in Canada, particularly with reference to the war years. One session was devoted to a symposium on atomic energy in relation to biology. Contributors to this were an introduction by G. M. Shrum; "Problems of Handling and Measuring Stable Isotopes", by H. G. Thode; "Measurement and Handling of Radioactive Isotopes", by A. J. Ciprianni; "Precautions for Workers Using Radioactive Isotopes", by G. H. Guest; "Botanical Problems", by J. W. T. Spinks; and "Radiation Genetics", by C. E. Ford.

It was natural that sessions held in British Columbia would include several papers on salmon and other fish. "Mortality in Pink Salmon" was discussed by A. L. Pritchard; "Fecundity and Mortality in Pacific Salmon" and "Migrations and Spawning of Sockeye Smolt" by R. E. Foerster; and "Movement of Fundy (Atlantic) Salmon" by A. G. Huntsman. Papers dealing with the butter sole and the lemon sole were read by J. L. Keith Stuart Ketchen, and A. L. Tester spoke on "Catch Limitations for Regulation of the B.C. Herring Industry".

SOLUBILITY OF INDUSTRIAL SILICEOUS DUSTS

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AND
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THE theory that tissue damage in silicosis is caused by silicic acid formed by solvent action of the plasma on inhaled particles stimulated the study of the solubility of airborne siliceous dusts and of the materials which give rise to them. The investigation of the solubility of mineral silicates is complicated by their peculiar properties. When a powdered siliceous mineral is shaken with water, the solution may contain particles which range from large colloidal particles to simple ions; and different workers have determined the solute gravimetrically after filtration[1], gravimetrically after ultracentrifuging[2] or colorimetrically as the silicomolybdate complex which is formed both with simple and with more complex colloidal silicic acids. King and McGeorge[3] consider that the colorimetric method is most likely to give figures representing physiologically active 'soluble silica'.

A mineral suspension does not reach equilibrium with the liquid phase within a reasonably short time, and a comparison of the solubilities of two substances must normally be made by comparing the quantities of solute after a fixed time. The apparent solubility depends on the temperature, the particle size of the dust and on the ratio of dust to solvent[4]. Since the extraction of dust particles in the lung by constantly changing lymph is so complex a process that any true imitation is impossible, investigators have attempted to compare solubilities under simplified fixed conditions, and with simpler solvents. For example, Briscoe and others[4] investigated the effect of water, Whitehouse[5] used 1 per cent sodium carbonate solution, Emmons and Wilcox[6] used plasma, while King and McGeorge[3] used ascitic fluid, similar to plasma but with less protein.

Experiments already reported[4] have shown that airborne industrial flint dusts have a relatively high silica-solubility in water at 100° C., and this solubility increases greatly as the particle-size is reduced. Under the same conditions industrial cement dusts show a much smaller solubility which varies but little with particle-size. Since flint produces silicotic lesions and cement does not, these results were accepted as supporting the general theory that dangerous dusts have a higher solubility than those which have no pathological action. Further investigation has shown that the solubility values are widely influenced by a number of additional factors. For example, the proportion of silica which dissolves

Table 1. Solubility of flint dusts in water at 100° C.

	Dust : water ratio	Raw flint	Calcined flint
Composition of dust			
SiO_2	—	76·0	79·1
CaO	—	12·7	6·5
Composition of solute			
SiO_2 (mgm. from 1 gm. dust)	1 : 100	3·9	1·2
	1 : 1000	8	24
CaO (mgm. from 1 gm. dust)	1 : 1000	12	64

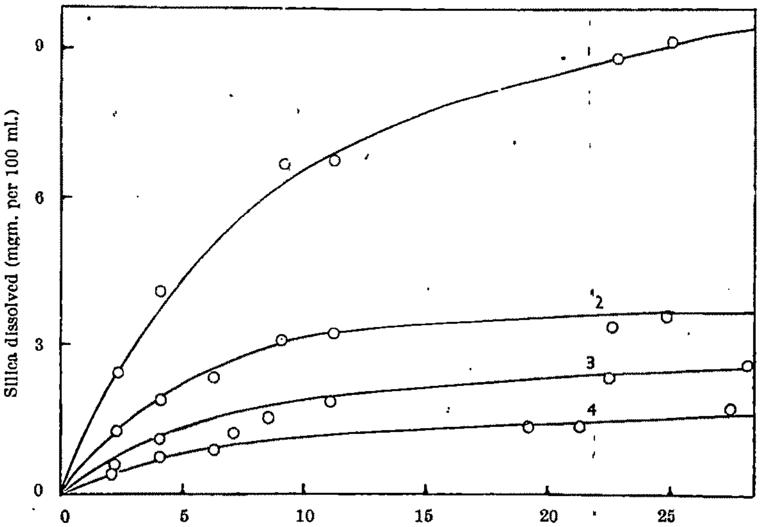

Fig. 1. Effect of carbon dioxide on the solubility of flint dust. (1) Ignited sample + CO_2; (2) normal sample + CO_2; (3) normal sample + air: (4) normal sample + air free from CO_2

from these industrial dusts depends markedly on the gravimetric ratio of dust to water, as is well illustrated by the figures for raw and calcined flint dusts given in Table 1.

Carbon dioxide will also affect considerably the solubility of dusts. Calcium is present mainly as carbonate in raw flint dust, and as carbonate, silicate and sulphate in calcined flint dust. The silica solubility figures shown by the dusts in the presence of carbon dioxide may be influenced by one or more of the following factors:

(*a*) Calcium silicate is decomposed by carbon dioxide, resulting in an increase in the silica which passes into solution, as is shown by re-igniting a sample of calcined flint dust, thus converting much of the calcium sulphate into calcium silicate. The solubility is much increased (Fig. 1).

(*b*) Carbon dioxide reduces the solubility of lime-free flint.

(*c*) Calcium carbonate increases the solubility of flint. The effects (*b*) and (*c*) were demonstrated by using calcined flint dust freed from calcium by washing with hot hydrochloric acid and water. Three 1-gm. portions of this sample were extracted with 100 ml. of water through which air, air freed from carbon dioxide, and carbon dioxide respectively were bubbled. The solubility values given after three days are compared in Table 2 with those obtained when the original flint dust was similarly extracted. It is apparent that, whereas the original dust is considerably more soluble in the presence of carbon dioxide than in its absence, the reverse is true of the acid-treated sample. Moreover, the solubility in the absence of carbon dioxide is much greater after acid extraction. King[7] found that the solubility of a number of dusts in Ringer solution was considerably increased after acid treatment. The addition of calcium carbonate, a substance which is present in most industrial dusts, to calcium-free flint dust increases its solubility to a maximum value in the presence of carbon dioxide; further addition lowers the solubility (Table 3).

Table 2

	SiO_2 (mgm.) dissolved from 1 gm. of dust		
	CO_2	Air	CO_2-free air
Acid-extracted dust	0·2	4·3	8·6
Untreated dust	2·0	0·9	0·6

The curves in Fig. 2 are plotted from data obtained by following the silica-solubility of calcined flint and cement dusts when extracted with water in the presence of carbon dioxide at 18° C. In both cases the water was replaced periodically. The rates of solution in the first and fourth extractions are illustrated. Flint shows a progressive decline in the rate of solution with each successive extraction, but the opposite is true for cement. Carbon dioxide increases the silica-solubility of cement to a value comparable with that of flint, and the value is increased in subsequent extractions until it is considerably higher than that of flint.

The experiments recorded indicate that solubility values can be greatly altered by variation in the conditions of extraction. Since the composition of the dust, particularly with respect to the form and concentration of the calcium compounds it contains, largely affects the solubility, a change in composition resulting from the removal of the more soluble constituents will alter the silica-solubility values during subsequent extractions. *In vivo*, the fluid affecting the particles is continually renewed, and possibly the solubility *in vivo* might be more nearly deduced from a study of the curves obtained by repeated extractions than from any single solubility

Table 3

$CaCO_3$ added (mgm. per 1 gm. flint)	Dissolved SiO_2 (mgm. per 100 ml.)
0	0·6
18	1·9
93	4·1
187	5·9
300	5·7
500	5·1
1000	4·3

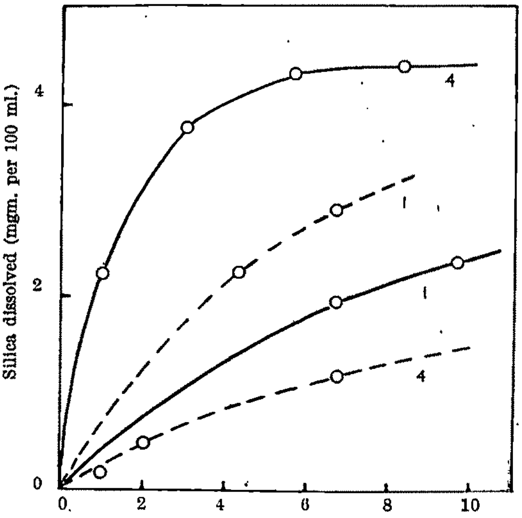

Fig. 2. Repeated extraction of flint and cement dusts by water saturated with carbon dioxide. Curves 1, first extractions: curves 4, fourth extractions.
——— Cement; - - - - flint

determination. Simple comparison of the solubilities of dusts using fixed conditions may give misleading results, and the correlation of solubility with pathological action by *in vitro* means will require a much more exhaustive study than has so far been attempted. In experiments designed to show the dissolution of dusts in the body, which will be reported elsewhere, cement has shown a relatively high solubility as compared with flint, sand (harmful dusts) and carborundum (harmless).

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FIXATION OF FREE NITROGEN BY BARK BEETLES

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IN 1912 and 1916 one of us isolated *Azotobacter* (*A. Sulcii*) from Aphides[1,2]. More recently, L. Tóth and others[3] proved by micro-Kjeldahl determinations that species of *Rhynchota* (Aphides, etc.) can also rapidly and considerably increase their nitrogen content by utilizing atmospheric nitrogen, though Smith[4] has not been able to confirm these results. This year, we made more progress in studying nitrogen fixation by the bark beetle, *Ips*, which has done much damage lately in Czech spruce forests.

The larvæ were mostly collected in mountain forests. Over successive intervals they were crushed with oxalacetic acid solution or similar reagent, oven-dried at 100° C., and subjected to Kjeldahl estimations. Using large amounts (0·5–0·8 gm.), as described by Csaky and Tóth[5], did not give good results. Samples often showed a decrease in nitrogen compared with the controls. Hence, only small numbers of larvæ (30–50) were used. It was also found that results depended on the age of the larvæ. Half-grown (approximately three weeks old) larvæ fixed atmospheric nitrogen, whereas fully fed and fat ones often showed a decrease. This agrees with our view[6] that the microbial symbionts of *Ips*, which occur in the peripheral (so-called adipose) tissue, soon find their way into the alimentary canal, where they are digested. Pupæ and young beetles do not fix nitrogen.

Though they were often found under the bark in great quantities, it was found inadvisable to collect larvæ directly in the forest. It was best to collect large samples (10–15 kgm.) of the infested bark and to isolate the larvæ in the laboratory, grouping them according to size. Even so, it was sometimes difficult to ensure that only one species of *Ips* was under examination, since several can occur together.

In the first series, using *Ips amitinus* L., from the Jizerské Mountains, in July 1948, the reagent used was either: (*A*) 0·088 per cent oxalacetic acid, 0·5 per cent dextrose, 0·7 per cent sodium chloride, 5·4 per cent dipotassium hydrogen phosphate; or (*B*), which contained 0·2 per cent succinic acid in place of the oxalacetic acid and 9 per cent of phosphate. Both had *p*H = 7·2, and 3 c.c. were used with each sample of larvæ.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·2466	1·7	control	—
2	0·2480	1·92	13 hr.	13 per cent
3	0·2473	1·81	24 ,,	6 ,,
4	0·2552	2·08	48 ,,	21 ,,
5	0·3590	1·52	control	—
6	0·3727	1·46	13 hr.	decrease
7	0·3634	1·61	24 ,,	6 per cent
8	0·3820	1·57	48 ,,	—

Reagent *A* was used for the first four samples, and reagent *B* for the others. Oxalacetic acid is considered preferable to succinic acid for this work.

Further results were obtained using samples of the same species from the same locality. Small larvæ and small amounts were used, but with slightly different reagents. Reagent *C* contained 0·1 per cent of aspartic acid and had a *p*H = 7·2; reagent *D* contained 0·0669 per cent of oxalacetic acid, 1 per cent dextrose and 12 per cent phosphate besides the sodium chloride; its *p*H = 7·7. Reagent *E* was the same as *A* except for dextrose (1·5 per cent) and 5·4 per cent K_2HPO_4, *p*H = 7·0. Reagent *F* contained 0·132 per cent of oxalacetic acid and the higher amounts of dextrose and phosphate, *p*H = 7·0.

In the following samples, reagent *C* was used for 1 and 2; reagent *D* for 3 and 4; reagent *E* for 5 and 6; and *F* for 7 and 8.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·0922	2·89	control	—
2	0·0923	3·19	12 hr.	10 per cent
3	0·0950	3·46	control	—
4	0·0885	3·64	12 hr.	5 ,,
5	0·1804	1·78	control	—
6	0·1798	1·84	12 hr.	3 ,,
7	0·3816	0·84	control	—
8	0·2572	1·33	12 hr.	60 ,,

A third series of tests was made with *Ips typographus* L. and *Ips* (*Pityogenes*) *chalcographus* L., from Broumov Rocks (August 1948), using an oxalacetic acid reagent.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·1919	1·46	control	—
2	0·1872	1·39	14 hr.	—
3	0·1819	1·12	24 ,,	—
4	0·2016	1·59	control	—
5	0·2086	1·67	14 hr.	increase
6	0·2142	1·57	24 ,,	—
7	0·1944	1·63	48 ,,	increase
8	0·2024	1·28	control	—
9	0·1887	1·11	14 hr.	—
10	0·1929	0·98	control	—
11	0·1863	1·09	14 hr.	increase 11 per cent

In the first three samples, the *I. typographus* were very small; small to medium specimens were used in samples 4–7 and medium ones in 8 and 9. The last two samples were young larvæ of *I. chalcographus*. In the first three samples the adipose tissue with symbionts had probably not developed, hence no nitrogen fixation. In the other samples of *I. typographus* the larvæ were probably too old, hence only a small increase or decrease of nitrogen was observed.

In the last two, *I. chalcographus* definitely fixed free nitrogen.

Another series of samples, also collected at Broumov in August 1948, were similarly treated with the same reagent, samples 1–6 with 2 c.c. and 7–11 with 3 c.c. *I. typographus* larvæ longer than 4 mm. were used in samples 1 and 2; *I. chalcographus* (small, young larvæ up to 2 mm.) was used in samples 3–6; samples 7 and 8 were medium-sized larvæ of the same species (up to 3 mm. in length), and samples 9–11 consisted of larvæ up to 5 mm. long.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·1597	1·36	control	—
2	0·1604	1·44	13 hr.	about 6 per cent
3	0·1457	lost	—	—
4	0·1414	1·09	13 hr.*	—
5	0·1492	1·27	26 ,,	6 ,,
6	0·1423	1·33†	72 ,,	21 ,,
7	0·2211	1·39	control	—
8	0·2314	1·59	13 hr.	14 ,,
9	0·2348	1·43	control	—
10	0·2388	1·41	13 hr.	—
11	0·2356	1·39‡	26 ,,	—

* Control. † In contrast with 4. ‡ Larvæ too old.

Thus, on the whole, in all four series there is an increase in the nitrogen content of the larvæ, agreeing with our cytological considerations. This also coincides with the rapid breeding of these insects, though it is not so remarkable as with Aphides. It affords an explanation of the damage caused by *Ips*, and the question arises whether this behaviour can be controlled and even put to some use.

More than a hundred eggs as well as many larvæ were used in order to isolate the symbiotic organisms. In the adipose tissues it is mainly *Torulopsis* (*Cryptococcus*), an extremely variable organism, in contrast with previous experience. In addition, many strains of *Candida* were isolated as well as various species of bacteria, some resembling *Azotobacter*.

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[2] Peklo, J., *Zemědělsky Archiv.*, vii (1916).
[3] Tóth, L., *et al.*, *Z. f. vergl. Physiol.*, **30**, 67 (1942); **32**, 300 (1944)
[4] Smith, J. D., *Nature*, **162**, 930 (1948).
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[6] Peklo, J., *Nature*, **158**, 795 (1946).

MUSHROOM RESEARCH STATION AT YAXLEY

By Dr. R. L. EDWARDS
Director of Research

RESEARCH on some of the problems of mushroom growing has been carried on for many years, particularly in France and in the United States. Two aspects have received special attention —the chemical and microbiological changes in horse manure during composting, and the fungus diseases of mushrooms and mushroom beds. The principal British work on mushroom cultivation is that of Ware on diseases and of Pizer on horse-manure composts. Recently the mechanization of transport has caused an increasing shortage and rise in price of horse manure, and this has become a major problem. Research on synthetic composts was in progress in the United States twenty years ago, and several formulæ have been published; but many of the materials used are not available in Great Britain. Since the end of the War, American growers and research workers have devoted more attention to methods of using the available supplies of horse manure more economically, and to mechanization of their cultural operations. Synthetic composts are not widely used. Some work on synthetic composts was done in France during the 'thirties, but horse manure is still the only medium used commercially.

In 1945 a group of British mushroom growers decided to set up their own research station at Yaxley, with the development of a commercially satisfactory synthetic compost as the main problem. A laboratory, two test-houses, and a covered turning shed were built, and work started in 1946. Six experimental crops have been grown during the past three years, and the main requirements for making a productive synthetic compost from wheat straw have been established. Small-scale tests on a commercial farm have given a yield comparable with the best obtained from horse manure.

As a result of consultations between the Mushroom Research Association, Ltd., which has financed the research station until now, the Mushroom Growers' Association (a specialist branch of the National Farmers' Union) and the Ministry of Agriculture, arrangements are being made for the Research Association to receive a grant from the Ministry and to publish all its results.

Each main cropping-experiment now includes twenty-four composts of about half a ton each, made up side by side in two rows, and separated by iron sheets, so that aeration and losses of heat and moisture are similar to those occurring in one long stack of compost. In this way the replicated comparisons and factorial experiments familiar in agricultural research can be carried out. Analyses and microbiological examinations of the composts are made at suitable stages. Some of the results obtained in this way are likely to interest workers on agricultural composts.

The main nutrients studied are nitrogen, phosphorus, potassium and calcium. The source of nitrogen is very important, organic nitrogen giving higher yields than the inorganic forms so far tested. An empirical mixture of twelve trace-elements has quite a pronounced effect; one problem for the future is to determine which of these are essential and in what proportions. Preliminary experiments with growth substances suggest that further work in this field may give results of practical value, in addition to its scientific interest. The number of mushrooms produced has been increased in several experiments, and earlier fruiting has been obtained.

Variations in the depth of beds and in the intervals at which spawn is sown have quite marked effects on the time of fruiting and on yield. In the course of these experiments the number and size of mushrooms produced are recorded daily, and some measurements of their rate of growth and the relation between dimensions and weight are made. In several instances factors affecting the number of mushrooms produced have been distinguished from those affecting their size, and this work will add much to our knowledge of the appearance of mushrooms in flushes, the opening of the veil, which is subject to considerable variations, and the exhaustion of mushroom beds. These fundamental aspects of mushroom 'macrobiology' have been almost entirely ignored in the past, and their elucidation is of scientific and practical interest.

VELOCITY OF LIGHT AND MEASUREMENT OF DISTANCES BY HIGH-FREQUENCY LIGHT SIGNALLING*

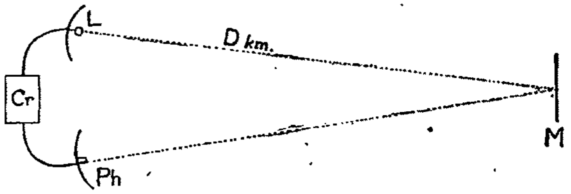
By E. BERGSTRAND

Geographical Survey Office, Stockholm

FIZEAU'S principle of determination of the velocity of light can be used for the measurements of lengths. In modern form an arrangement according to this principle is shown in Fig. 1.

L is the source of light, having a spherical mirror to collect the light in a beam. The source is influenced by high-frequency tension from the crystal-controlled oscillator *Cr*, and thus the intensity of the light emitted varies with the frequency of the oscillator. *M* is a plane mirror, which reflects back the light to the phototube *Ph*. The phototube gets its operating tension from the oscillator *Cr*. Accordingly, the sensitivity of the tube varies with the same frequency as the intensity of the emitted light. As the rapid blinks of light take a certain time to cover the distance to *M* and back again, the moments of high sensitivity of the tube will be more or less timed to the incoming blinks, depending on the distance *D*. Fig. 2 shows how the recording current directed by the phototube depends on the distance *D*.

Fig. 1



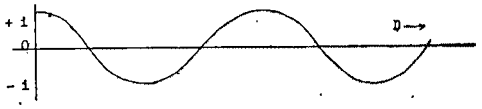


Fig. 2

A low-frequency alternating phase displacement of 180° of the high-frequency light variations makes the current exactly symmetrical with respect to the zero-line. By this means we get sharply marked positions of the mirror where the current is zero. The distance between the zero positions depends on the frequency of the oscillator *Cr*. In the actual apparatus, the frequency is 8·3 Mc./sec., corresponding to a wave-length λ of 36 metres. Thus the current becomes zero every ninth metre in accordance with the expression

$$D = K + \frac{2N - 1}{8} \cdot \lambda,$$

where *D* is the distance to be measured, *K* is a constant, depending on the apparatus used, λ is the wave-length, depending on the frequency and here being 36 metres, *N* is a whole number + 1, 2, 3, 4, ... Usually *N* is known from an approximate knowledge of *D*; if not, it may be determined by variation of λ. The values of *D* corresponding to $N = 1, 2, 3, \ldots$ are constant to the same degree as the frequency is constant, that is, to one part in ten millions; they depend also on the accuracy with which the atmospheric conditions are known. Thus the influence of temperature is 0·9 cm. per degree C. and 0·4 cm. per millibar air pressure, for a distance *D* of 10 kilometres.

In the field, the mirror *M* usually is not placed exactly at a zero-point. We then decrease the frequency slightly from its 'normal' value. The farthest zero-point glides out and passes the mirror. Just then the photo-current changes its direction and passes through zero. We now read off the change of frequency and get the distance of the mirror from the farthest 'normal' zero-point. In this way we get the extreme value of the distance to be determined. The other end is fixed in a similar way. Here we use the value of *D* for $N = 1$. This distance, about 1 metre, is very constant. By means of a variable loop of light, it can be determined or controlled. To get the main constant of the apparatus, the first determination is made on a known base-line.

At a value of *D* of 9 km., the sensibility of adjustment commonly was 0·4 cm. as a mean error of six determinations during a quarter of an hour. Measurements on different days showed a maximum divergence of 3 cm.

Knowing the frequency, we determined the velocity of light *in vacuo* to be 299·796 ± 2 km. per sec. We intend to make further measurements in March; therefore, the values given above should not be considered as definite.

A.G.A., Stockholm, intend to manufacture the 'geodimeter' for sale.

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Bergstrand, *K. Vetenskapsakad. Arkiv, M.A.F.*, Nr. 30 (Stockholm, 1943); Nr. 20 (Stockholm, 1949); *Acta Com. Geod. Baltique* (Helsinki, 1948).

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* From a paper presented at the International Union of Geodesy and Geophysics, Oslo, 1948.

PHOTOMETRY OF THE CONTINUOUS SPECTRUM

PROF. W. M. H. GREAVES, president of the Royal Astronomical Society, delivered his presidential address on February 14, 1948, to the Society at Burlington House, selecting as his topic "The Photometry of the Continuous Spectrum". As Prof. Greaves pointed out at the beginning of his address, he was encouraged to make the attempt of presenting a survey of the subject by the consideration that it "can be used to illustrate the way in which Natural Knowledge is advanced by an interplay between observational and theoretical investigations". The address involves so many technical matters and is so comprehensive that no attempt can be made in this short notice to deal with it in detail; and those who are specially interested in the subject should study the paper itself (*Mon. Not. Roy. Astro. Soc.*, **108**, No. 1; 1948).

A general description is given of the kind of measurement which is undertaken in this comparatively new technique and also of the relation of this technique to that of classical photometry; after this there is a review of the theoretical work on spectral energy distribution which has taken place during the last two decades. The theory of the radiative equilibrium of stellar atmospheres had been independently developed by Lindblad and Milne, and, on the assumption that the stellar absorption coefficient did not vary with wave-length, Milne showed that the stars would radiate like black bodies. The calculated values for the sun's centre-limb contrast, which agreed well with the available data, seemed to substantiate this view, and the theory gave a definite set of temperatures—those of the Fowler–Milne scale—which were approximately identified with colour temperatures. The well-known work of Greaves, Davidson and Martin at Greenwich on the gradient difference between stars of spectral types $B0$ to $B3$ and stars of spectral type $A0$ showed a colour-temperature of 18,000° for $A0$-stars at a wave-length of 5000 A. as against the Fowler–Milne value of 10,000°; and it was necessary to discard Milne's provisional assumption that the stellar absorption coefficient did not vary with wave-length.

Reference is made to the advances which attended the work of McCrea, who calculated the emergent radiation for a model star composed entirely of atomic hydrogen, and of Pannekoek, who independently repeated McCrea's investigations, taking into account the contribution of metallic atoms in the stellar atmospheres. Also dealt with is the observational progress which was made during 1934–39 through the work of Barbier, Chalonge and their collaborators at Jungfraujoch, of Kienle and his colleagues at Göttingen, and R. C. Williams at Ann Arbor. Many others matters are included in the address, and towards the end Prof. Greaves expressed his personal opinion that, though the existence of intrinsic reddening in addition to space reddening has not been absolutely established, the balance of evidence favours the view that reddening by interstellar scattering is not the only process involved. Before attempting the task of interpretation, further measures are very desirable, and in particular the study of the variation of gradient excess with wave-length from the near infra-red to the near ultra-violet.

RUBBER RESEARCH INSTITUTE OF THE DUTCH EAST INDIES

THE Rubber Research Institute of the Dutch East Indies at Buitenzorg, Java, has recommenced publication after the delay of several years caused by the Japanese occupation, and a number of its recent reports contain points of interest.

Publication No. 38 shows that rubber obtained immediately after tapping the tree is readily soluble in petroleum ether, but on standing in the light it gradually becomes insoluble, especially if stored in the form of latex. These changes naturally complicate the supposed distinction between 'sol' and 'gel' rubber.

Publication No. 39 emphasizes the important bearing which the method of preparation of rubber has upon the physical properties of the final vulcanized article, especially in respect of water absorption and tension strength in the wet state; for example, whole-latex rubbers are much stronger when dry than when wet.

A study of the nature of the naturally occurring antioxidants in rubber latex (Publication No. 54) has shown that the amino-acids have a remarkably powerful antioxidant action. The spontaneous coagulation of *Hevea* latex has frequently been believed to result from progressive lowering of *p*H, but it still occurs even when the *p*H is kept constant, and work done in Java (Publication No. 58) suggests that the removal of magnesium ions, as a fatty soap, is the main cause of coagulation.

The vexed problem of the value of incorporating rubber powder in roadways receives a contribution in Publication No. 61, where it is shown that the durability of bituminous coatings in Java is much improved by the addition of rubber powder.

Some of those who use raw rubber have for long maintained that the 'fine hard Para', produced under primitive conditions in Brazil, is of superior quality to that produced on plantations. This controversy will presumably be revived by the report, given in Publication No. 62, that smoked sheets produced under primitive conditions in West Borneo may be of superior quality to those produced by native labour, following modern practice, in south Borneo.

The marked differences between fresh latex and old latex, some of which were commented on above, are responsible for an interesting development which is fully described in Publication No. 68. When old vulcanized latex is coagulated, a continuous coagulum is obtained; but if fresh latex is used for the vulcanizing process, and the product is then coagulated, the coagulum is not coherent and forms a powder, known as 'Mealorub', on drying. This very economical method of producing a powdered rubber will be watched with considerable interest, especially from the point of view of its use as a means of preventing the flow of road bitumens in hot weather, and as a means of binding certain types of road aggregates.

R. G. NEWTON

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 28

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. C. Rimington: "Haem Pigments in Nature".* (Further Lecture on March 7.)

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. L. R. G. Treloar: "Rubber Physics applied to Engineering Problems".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the UNIVERSITY COLLEGE OF DUBLIN CHEMICAL SOCIETY and the WERNER SOCIETY, in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. T. Dillon: "Researches on the Chemistry of the Algæ".

CHEMICAL SOCIETY, OXFORD SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Mr. C. S. Robinson: "Research and Productivity in Industry" (Alembic Club Lecture).

Tuesday, March 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. B. Freeman: "The Life of Fleas".*

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. T. Yeldham Unwin: "A Tale of Two Cities and other Places".

Wednesday, March 2

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. C. Cherry: "The Analogies between the Vibrations of Elastic Membranes and the Electro-magnetic Fields in Guides and Cavities".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Tore Levring (Göteborg): "Submarine Daylight, Photosynthesis and Vertical Distribution of Marine Algæ".* (Further Lecture on Friday, March 4.)

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. C. G. Conway: "Metallurgical Problems involved in the Manufacture of Components for Jet Engines".

Thursday, March 3

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY, NORTH WALES SECTION (in the Edward Davies Chemical Laboratories, Aberystwyth), at 5 p.m.—Dr. E. A. Moelwyn-Hughes: "The Liquid State".

Royal Meteorological Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Prof. Gordon Manley: "British Climatic Fluctuations since Queen Elizabeth's Day".

Institution of Civil Engineers, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. H. J. B. Harding: "Site Investigations, including Boring and other Methods of Surface Exploration".

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Mr. M. A. Alexander: "Some Radar Applications".

Leeds Metallurgical Society (in the Chemistry Department, The University, Leeds), at 7 p.m.—Mr. E. W. Colbeck: "Metallurgical Problems in the Field of Atomic Energy".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

Friday, March 4

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. T. C. Williams: "Research in the Bedding Industry".

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. E. Ernest S. Brown: "Work for Amateur Geologists" (Presidential Address).

Institution of Mechanical Engineers (joint meeting with the Institution of Electrical Engineers, at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. W. F. Harlow: "Causes of Flue-gas Deposits and Corrosion in Modern Boiler Plants".

Royal Statistical Society, London Group of the Industrial Applications Section (joint meeting with the London Section of the Society of Chemical Industry, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. G. P. Box: "Statistical Methods in the Interpretation of Experimental Results".

University of London (at the Royal Holloway College, Englefield Green, Surrey), at 8 p.m.—Prof. Paul Dienes: "Science and Ethics".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "The Foundation of the Royal Institution".

Saturday, March 5

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on "Nutrition and Fertility".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Air Safety".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Animal Husbandry Adviser at the British Middle East Office in Cairo—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.27/49 (March 5).

Demonstrators at the Military College of Science, Shrivenham, near Swindon, in Mathematics (Ref. A.299/48A), Ballistics (Ref. A.299/48A), Physics (Ref. A.299/48A), Chemistry (Ref. F.706/48A), and Metallurgy (Ref. F.707/48A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 5).

Statistician to maintain statistical sub-offices at Entebbe and Dar-es-Salaam and to carry out surveys on behalf of the East African High Commission—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1 (March 5).

Senior Scientific Officers or Scientific Officers, Experimental Officers or Assistant Experimental Officers, for work on safety measures and other research problems connected with the industrial use of explosives and high pressure acetylene, in a Ministry of Supply Research and Development Establishment in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1189/48A (March 10).

Senior Scientific Officers, Scientific Officers, Experimental Officers and Assistant Experimental Officers (unestablished) with practical experience of the working and deformation of metals or of experimental technique in determining alloy constitution, or some knowledge of powder metallurgy, metallography, physics of metals, X-ray crystal analysis or corrosion problems, in Ministry of Supply Research and Development Establishments in London and South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1190/48 (March 10).

Principal Scientific Officers or Senior Scientific Officers, with recognized qualifications in veterinary science with research experience in bacteriology, for unestablished veterinary research posts in a Ministry of Supply Research and Development Establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (March 10).

Scientific Officers with good Honours degree in a biological science or in chemistry, with research experience in biochemistry, physiology, pathology, pharmacology, or bacterial chemistry, and Experimental Officers with a minimum of three years laboratory experience in pathology, bacteriology, biochemistry or physiology, at Ministry of Supply Research and Development Establishments in Wiltshire and Hampshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.550/48 (March 10).

Chemist or Chemical Engineer for fundamental theoretical and experimental work including work on corrosion, a Chemical Engineer for development of chemical processes subsequent to the laboratory stage and design of plant from pilot plant to larger scale, a Physicist for design, development, manufacture and operation of special instruments for chemical plant, and a Mechanical Engineer for experimental work on problems of stress measurement and high pressure technique, etc., in the Chemical Engineering section of a Ministry of Supply Research and Development Establishment in Essex—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1188/48A (March 10).

Experimental Embryologist or Immunologist in the Department of Zoology—The Secretary and Registrar, University College of North Wales, Bangor (March 11).

Physicist in charge of a section concerned with the application of radio-active tracer elements—The Registrar, The University, Reading (March 12).

Senior Scientific Officers (with good honours degree in chemistry or physics or equivalent qualification) and Scientific Officers (with good honours degree in chemistry or equivalent qualification), for analytical work in connexion with atomic energy development (Ministry of Supply Chemical Inspectorate)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.48/49A (March 12).

Lecturers in the Department of Electrical Engineering (Electrotechnics)—The Registrar, The University, Liverpool (March 14).

Readership in Theoretical Physics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

Professor of Organic Chemistry, and a Professor of Theoretical Physics, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 31).

Chair of Physiology at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 31).

I.C.I. Research Fellowships in Chemistry or Physics, or some allied subject such as Biochemistry, Chemotherapy, Pharmacology, Metallurgy or Engineering—The Registrar, The University, Liverpool (April 15).

Ramsay Memorial Fellowships for Chemical Research—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 16).

Geologists in the Colonial Geological Survey Service (mainly in the East and West African Dependencies, the Federation of Malaya, and the British Solomon Islands Protectorate)—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Industrial Chemist at a Ministry of Supply factory in Nottinghamshire, to be responsible under the Chemist-in-charge for the chemical, metallurgical and testing laboratories and the electro-deposition plant at a heavy engineering factory—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.65/49A.

Graduate or A.R.I.C. for analytical research for metallurgical problems—The Director, British Cast Iron Research Association, Alvechurch, Birmingham.

Graduate (or equivalent) as Assistant in enquiry laboratory dealing with works problems submitted by member firms—The Printing, Packaging and Allied Trades Research Association, Randall Road, Leatherhead, Surrey.

Physical Chemist (Assistant Scientific Officer or Scientific Officer grade) with an Honours degree in Chemistry, to carry out research on rubber latex and other emulsion systems—The Secretary, Research Association of British Rubber Manufacturers, 105–7 Lansdowne Road, Croydon, Surrey.

Bacteriologist (male) for work in the Stack Laboratories, Khartoum—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Bacteriologist'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Medical Research Council. Memorandum No. 19: The Rh Blood Groups and their Clinical Effects. By Dr. P. L. Mollison, Dr. A. E. Mourant and Dr. R. R. Race. Pp. 74. (London: H.M. Stationery Office, 1948.) 1*s*. 6*d*. net. [169

Field Crop Abstracts. Vol. 1, No. 1, January 1948, Abstracts 1 to 446. (Aberystwyth: Commonwealth Bureau of Pastures and Field Crops, 1948.) Annual subscription, 35*s*. [169

Society of Public Analysts and other Analytical Chemists: Physical Methods Group and Biological Methods Group. Symposium on Methods of Penicillin Assay: their Purpose, Scope and Validity. Pp. iv+34. (Cambridge: W. Heffer and Sons, Ltd., 1948.) 3*s*. 6*d*. net. [209

Other Countries

Annual Report of the Coconut Research Scheme for 1946. Pp. 22. (Colombo: Government Publications Bureau, 1948.) 45 cents. [149

United States Department of Commerce: National Bureau of Standards. Circular No. 462: Ionospheric Radio Propagation. Pp. iv+209. (Washington, D.C.: Government Printing Office, 1948.) 1 dollar. [149

Teknik Dergi (Turkish Technical Review). Yil. 1, Sayi 1, Agustos 1948. Pp. 48. (Istanbul: Teknik Dergi, 1948.) 1 T.L., 1 dollar; annual subscription, 12 T.L., 10 dollars. [169

Sugar Research Foundation. Scientific Report Series, No. 10: Chromatography of Sugars and related Substances. By Dr. Wendell W. Binkley and Prof. Melville L. Wolfrom. Pp. v+34. (New York: Sugar Research Foundation, Inc., 1948.) Free. [169

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DEVELOPMENT OF BACKWARD TROPICAL REGIONS

IN a memorandum issued with the first report of the Select Committee on Estimates for the session 1948–49*, the Colonial Office replies to some earlier criticisms by the Committee suggesting that there was no coherent strategy of economic planning in the schemes for Colonial development which had been put forward. The Colonial Office in its reply refers to an unpublished memorandum of April 1944 on "The Planning of Social and Economic Development in the Colonial Governments", which states that the two primary objectives of British Colonial policy are the promotion of the best development of the social and political institutions of Colonial peoples, and of their true welfare in the widest sense. The memorandum assumes that the planning of developments to be undertaken in the Colonies would be 'outline' planning in the sense of providing a general framework while leaving a more or less substantial residue of decisions about production and consumption to private planning or individual initiative. On this interpretation of planning, in which strategy is defined as the selection of objectives and the marshalling of the forces necessary to reach those objectives, the Colonial Office submits that there has been a perfectly coherent strategy. The reply goes on to point out that from the beginning it was made clear that the ten-year 'developments' were not to be imposed from Whitehall, but were to be the creation of Colonial Governments and indeed of Colonial peoples themselves. The execution of the plans and the tactics employed are then defended, but in a way which is not altogether convincing.

There is, perhaps, less difference between the Colonial Office and the Select Committee on Estimates than the Colonial Office is disposed to admit. Far more stress was laid by the Select Committee on the necessity of associating the Colonial peoples with development plans at an early stage than would appear from this reply. The Colonial Office indicates the difficulties in co-ordinating the planning of developments in forty-five separate territories; but it never really answers the fundamental criticism that early information on the acute shortages of equipment, materials and man-power, which have brought certain schemes into acute competition for capital equipment required urgently for European reconstruction and development, could only have come from Whitehall. In the field of capital equipment it would seem that a case can be made for criticism. The Select Committee recommended that schemes of Colonial economic development requiring equipment in short supply should be framed in consultation with a planning authority in the United Kingdom having responsibility for allocation among home needs, export demands and all forms of Colonial development. This recommendation the Colonial Office regards as impracticable; but it recognizes the importance of the considerations on which the recommendation is based and is attempting to meet the need in other ways. Other recommendations of the Select Committee, it is stated, have already been adopted.

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* First Report from the Select Committee on Estimates. Session 1948–49. (London: H.M. Stationery Office, 1948.) 9*d*. net.

Despite this rather heavy-handed reply, it would appear that the criticism of the Select Committee has not been wide of the mark and has had an effect. Moreover, it is obvious from recent discussions on the progress of the groundnut scheme in Tanganyika that the bearing of the general criticism of the Select Committee on the operations of the Overseas Food Corporation has not escaped notice. It has at least strengthened the hands of those who are pressing for information both on the progress of the groundnut scheme and for parliamentary discussion on the activities of the Corporation. President Truman's recent proposal for American participation in the development of backward areas adds a further powerful reason for full public discussion of all the issues involved in Colonial development.

That there is much of scientific interest in such discussion requires no stressing. Thus, Mr. A. J. Wakefield read a paper on the groundnut scheme in East Africa before Section D (Zoology) at the British Association meeting at Brighton in which he emphasized the long-term character of the project and the way in which it is associated with questions of the production of other crops ; he showed that it calls for the services of agronomists, soil chemists and surveyors, entomologists, pathologists, plant breeders, biochemists and others. At the same meeting, Sir Frank Stockdale stressed biological aspects of Colonial development, while the contribution of the scientific worker to human welfare in the Colonial territories was also brought out in the addresses of Lord Rennell of Rodd and of Dr. E. Scott Robertson, as well as in a specific discussion on scientific aspects of Colonial development before Section E (Geography).

Since that meeting, the publication of the four reports prepared for the Tsetse Fly and Trypanosomiasis Committee, reviewed by Sir Philip Manson-Bahr in these columns (*Nature*, January 22, p. 118), have demonstrated the thoroughness with which the task of survey and control of trypanosomiasis in Central Africa is being carried out and its bearing on Colonial development as well as health and welfare. The announcement of the new drug 'Antrycide' indicates the way in which scientific and industrial research in Britain is continually providing the medical and veterinary worker, the protozoologist and entomologist with new weapons, and opening up fresh prospects of controlling the major diseases and pests that ravage human and animal life and limit development in tropical areas. Some of these possibilities have no doubt been considered by the International Scientific Committee for Trypanosomiasis Research which met in London on February 8. This non-government standing committee of scientific men from the United Kingdom and the Colonies, France, Belgium, Portugal, South Africa, Southern Rhodesia and the Sudan, was formed as a result of the international conference held at Brazzaville in French Equatorial Africa in February 1948.

An important section of the report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast not only praised the work of the West Africa Cacao Research Institute as basic to the maintenance of the cocoa industry in the Gold Coast, but also suggested an extension of research involving a considerable increase in both the facilities and staff at the Institute. It will also be recalled that in launching the groundnut scheme, the Government expressed the belief that its long-term importance might lie less in increasing the supply of fats for Britain and the rest of Europe than in its practical demonstration of the improved productivity, health, social welfare and prosperity which scientific agriculture can bring to Africa. In a recent address to the Manchester Statistical Society, urging the need for more capital for the Colonies, Prof. Arthur Lewis emphasized that more than this is required. The fundamental needs in all colonies are, in fact, the same. Apart from greater capital investment, the people must learn the laws of good husbandry. Proper cultivation, protection against erosion, the planting and felling of trees, selective breeding of livestock and irrigation where possible are fundamental in the development of every Colony. Behind all lies the need for further research in tropical agriculture: research into plant diseases and fertilizers, the breeding of immune varieties, methods of conserving water, the elimination of pests and the preservation of animal health.

The demands that are thus made on the Colonial Powers may well absorb all the surplus resources of Western Europe for years to come, and indeed a large part of those of the rest of the industrial countries of the world. This demonstrates the immediate significance of President Truman's proposal. This proposal would appear to accept and endorse the recognized basis of British Colonial policy, namely, that the development of the backward areas can only be achieved with outside technical and scientific assistance and large capital investment which must be carefully watched and controlled to avoid exploitation ; and it offers to put the vast resources of the United States behind a great effort to carry out such a policy throughout all the under-developed areas of the world. Such association in itself may well prevent misunderstandings, which may sometimes arise when economic development appears to clash with the advance towards full self-government, and so forestall misrepresentation. The announcement that the Economic Co-operation Administration has approved the British Government's proposal for the augmentation of the Colonial Surveys by about fifty trained American workers, whose salaries would be met by that Administration, is a welcome sign of the beginning of such co-operation.

Research and education must, indeed, precede capital development, and it is a task which Great Britain at present finds peculiarly difficult, owing to its straitened resources of scientific man-power, to discharge adequately even within the Colonial Empire. It may well be hoped, therefore, that one effect of Mr. Truman's proposal may be so to implement both the Fulbright Act, which provides for sending

Americans to study, teach and engage in research abroad and for the cost of travel of nationals of other countries who wish to visit the United States for similar reasons, and also the Smith - Mundt Act of January 1948 for the establishment of an educational exchange service. An agreement between the Governments of the United Kingdom and the United States to put the Fulbright Act into effect was signed on September 22, 1948, but in the present currency situation the chief beneficiaries will be Americans. If, in view of the President's proposal, Congress now makes the necessary appropriations under the Smith - Mundt Act for international co-operation in the interchange of persons, knowledge and skills, the rendering of technical and other services and the interchange of developments in the field of education, the arts and the sciences, the purpose of the Fulbright Act may still be achieved.

Meanwhile, it is worth noting that the Colonial Office has now begun to issue a *Journal of African Administration*, one of the aims of which is to serve as a link between research and administration; the first issue refers to contacts which are being developed between the Colonial Office and the appropriate departments and institutions of foreign Colonial Powers. Here is further encouragement for men of science working in fields touching on human welfare, health and agricultural development, who have already recognized how much international co-operation can do to make their efforts fully effective in areas such as tropical Africa. President Truman's proposal is rightly linked with the European recovery programme and the firm establishment of world order; but there are few fields in which Anglo-American co-operation, the pooling of knowledge and scientific and technical resources and the interchange of staff, could contribute more quickly and richly to human welfare and social advance throughout the world than in the development and education of the backward areas of the world.

TAXONOMY OF THE HAWKWEEDS

A Prodromus of the British *Hieracia*

By H. W. Pugsley. (Journal of the Linnean Society of London, Botany, Vol. 54.) Pp. iv+356+17 plates. (London: Linnean Society, 1948.) 60*s*.

THE hawkweeds have long been known as a group of plants presenting peculiar difficulties to taxonomists. The general facts can be simply stated: in most parts of the generic range the hawkweeds are more or less locally limited entities which morphologically differ definitely, but not greatly, from other entities. These microspecies, or whatever they be called, come true in their differential characters from seed. In the British Isles, the northern and western parts are richest in *Hieracia*, and in the past their study has attracted many British botanists. The late Mr. H. W. Pugsley published "Notes on British Hawkweeds" in 1920, so that it is safe to say that the present prodromus is the result of more than a quarter of a century's investigations.

Within the limits of a 'micro-taxonomical' subject the work is in many ways excellently done. The descriptions are clear, sufficiently full yet concise, and easily comparable one with another. There is judicious citation of specimens and localities. The history of the classification of British *Hieracia* is adequately considered, and there is an interesting section on their morphology.

A conspectus of accepted species classifies these into sections and series; but it is unfortunate that no artificial key is provided to the latter. The greater part of the prodromus consists of descriptions with keys to the 260 groups recognized as species, the keys being generally placed under the series into which the species are classified. A considerable number of such species are here described and named for the first time. Under some of the species varieties are accepted. There is an index to the species and subsidiary groups, and seventeen plates show plants in black-and-white outline.

Various questions arise in perusing this volume. Modern research has shown that many *Hieracia* are apomictic—they set seeds without fertilization. Much of this cytological research has been done in Scandinavia, and apparently British hawkweeds have not been examined for their chromosomes or the absence of fertilization. There is, however, very little doubt that the entities accepted by Pugsley as species are apomicts (or groups of apomicts). Genetically, apomicts are the equivalent of clones. Unlike clones that are propagated, as clones, only by vegetative means, they spread by seeds which reproduce the clone. With these peculiarities there are good arguments for maintaining that apomicts should be taxonomically treated neither as species nor as varieties, but should be classified as distinct categories. It is to be regretted that Mr. Pugsley did not explain clearly the general principles by which he determined which of the presumably apomictic entities should be considered 'species' and which 'varieties'.

Another matter that may be disputed is his treatment of the part played, in the more or less long distant past, by hybridization. On this matter his statements appear to be confused. If *Hieracia* be completely apomictic, at the present day, hybridization cannot occur between the apomicts; but this does not mean that hybridization did not occur when amphimixis was the rule in the genus. Indeed, some cytologists have held strongly that hybridization is an important cause of apomixis.

W. B. TURRILL

THE SPECIES OF MODERN MAN

Human Ancestry from a Genetical Point of View

By Professor R. Ruggles Gates. Pp. xvi+422+27 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 42*s*. net.

THE subdivision of modern man into distinct species rather than into "races" is justified in the first instance, says Prof. R. Ruggles Gates in his new book, on the score of "convenience" (p. 11). "Consistency in nomenclature and methods of classification necessitate the recognition of several species of living man", he adds (p. 406). Like Prof. Ruggles Gates, anthropologists well appreciate the difficulty of distinguishing (except arbitrarily) clear-races of mankind and of specifying the criteria by which they are to be recognized. Indeed, at the recent International Anthropological Congress at Brussels the complexity of the problem received fresh affirmation. One might have hoped then that the first-fruits of Ruggles Gates' advocacy of the "convenience and cogency" of human species would be that the latter would prove easier to detect than the conventionally recognized 'races' or variants. However, he does not appear ready yet to adjudicate on the taxonomic rank of the many more or less distinctive groups which he recognizes. (The elaboration and adornment of the charts on p. 56 and p. 161 illustrating these groups need not be taken too seriously.) Towards the end of the book (p. 388) he puts forward five strong claimants to the rank of species in the Caucasian, Mongolian, Australian, Negroid and Bushman stocks; but he does not, unfortunately, justify this selection by any detailed reference to the taxonomic and phylogenetic criteria which he insists are at hand to establish species differences; nor is it made plain in which way these particular 'species' exemplify "consistency in nomenclature and methods of classification". Indeed, it comes rather as an anticlimax to find, near the end of the work (p. 378), that for the conferment of species rank one may have, after all, to fall back on the "opinions of a competent systematist".

Ruggles Gates makes his claim on the score not merely of "convenience"; much of the book is devoted to arguments based on palæontological data. According to him modern man may be grouped in distinct species because the taxonomic differences represent the end-products of evolution along largely isolated lines of development. Continental separation has given rise to the four or five groups which he would regard as distinct species. They have, according to him, been developed from quite separate ancestral stocks of the morphological levels typified by *Pithecanthropus* and *Javanthropus* in the Australian region, *Sinanthropus* in the Far East, Neanderthal man in Europe, and *Africanthropus* and Rhodesian man in Africa. It will be recalled that Weidenreich[1] was the foremost advocate of the view that *Homo sapiens* (the Neanthropic level) had emerged from the more primitive Neanderthal (or Palæanthropic level), and that the latter in turn had its origin in the *Pithecanthropus–Sinanthropus* (or Archæanthropic level). Another view, that of Sergi[2], Le Gros Clark[3], and others, is inclined to the belief that Neanderthal man and *Homo sapiens* represent divergent branches from a geologically earlier group combining features of both, as exemplified in the remains from Steinheim, Saccopastore, Krapina, Mt. Carmel, and elsewhere. There is some uncertainty as to the relationship of this group to the Archæanthropic level.

The emergence of modern man is thus capable of various interpretations, even if it is assumed that the transformation and dispersal at each level have taken place at a single centre. Ruggles Gates finds it easier to believe that this transformation has taken place independently, and presumably at different times, in four or five centres, and that the descendants of these rather dissimilar ancestors have undergone an extraordinary degree of parallelism in their different lineages, yet not enough to obscure their specific differences. It would seem, however, that Ruggles Gates has allowed himself much elasticity in his usage of the concept of 'parallelism'. As applied to man, his usage does not, in spite of his implied claim (p. 39), conform to that of Le Gros Clark. In the latter's interpretation (which is the one generally understood) parallel variations are essentially secondary and often superficial, and this is true, in fact, of many of the accepted cases of parallelism in other animal groups instanced by Ruggles Gates himself. If palæontologists of the standing of Broom and Le Gros Clark do not attribute the humanoid resemblances between *Australopithecus* and *Homo* to merely parallel variations, to describe the similarities among modern men as 'parallelisms' seems completely inconsistent.

Quite apart from the difficulties in Ruggles Gates's phylogenetic interpretations, the arguments based on palæontological data (an impressive compilation in this book) prompt serious misgivings. The author gives credence to many expressions of palæontological opinion which are far from commanding general acceptance. Evidence based on remains such as those of *Eoanthropus*, *Meganthropus*, Kanam man and *Africanthropus*, to mention a few, cannot at the present time, in fact, be used as a basis for any far-reaching generalizations. The material is morphologically and geologically too uncertain. Even where there are well-preserved remains, much caution is needed in accepting the speculations of palæontologists on the affinities of particular fossils. One may take an instance on which Prof. Ruggles Gates places great emphasis—the relationships of the Rhodesian skull. The affinities of this specimen to modern and to Boskop man, to the Bushman, to ancestral Negroes, or Neanderthal man have been interpreted so variously as to yield a remarkable criss-cross of contradictory hypotheses. These probably cancel one another out, as a recent critical article by Dr. L. H. Wells[4] would suggest. In handling the palæontological data, opposing points of view have not, in the reviewer's opinion, been given sufficient critical consideration by Prof. Ruggles Gates. This is the work's most obvious inadequacy, and one which goes far to weaken the thesis the author is so intent to sustain.

J. S. WEINER

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[1] Weidenreich, F., "Apes, Giants and Man" (Univ. Chicago Press, 1946).

[2] Sergi, S., *Man*, 48, 76 (1948).

[3] Le Gros Clark, W. E., *Biol. Rev.*, 15, 202 (1940).

[4] Wells, L. H., "Robert Broom Commemorative Volume", 133 (Spec. Pub. Roy. Soc. of S. Africa, 1948).

SYLVICULTURAL STATISTICS

The Silviculture Research Code

Vol. 2: The Statistical Manual (Being the Application of Statistical Methods to Silvicultural Research in India). By A. L. Griffith and Bakshi Sant Ram. Pp. viii+214. (Dehra Dun: Forest Research Institute, 1947.) Rs. 11.2; 17*s*. 6*d*.

WORKERS in the biological sciences need statistical methods as a tool in the ascertainment of results to be derived from experimentation; in particular, when experiments are of the field order, modern applications to the design and analysis of experiments, mainly the work of R. A. Fisher, are essential. The question then arises whether certain standard texts are sufficient, or whether there is need for a book dealing with methods particular to the special field. The "Silviculture Research Manual" of 1931 is out of date, and it has been decided to publish a new "Code" in three volumes. The opportunity has been taken to expand the treatment of statistics from a single chapter, by H. G. Champion, in the former manual to an entire volume which, although vol. 2 of the "Code", is the first to be published.

It is undoubtedly a convenience for sylviculturists to have their own all-embracing text, although as a matter of fact the only feature of the work under review that is peculiar to sylviculture lies in the numerical data, and the actual experiments chosen for purposes of illustration. Generally, the volume is an expository presentation of those parts of the theory and application of statistical methods that are needed in the domain of field experimentation. Full acknowledgment is made of the sources of the compilation, and, although the authors are evidently not mathematical statisticians, the selection of the material and the general presentation are on the whole sound, while a welcome feature is the considerable detail given to all the calculations; so much so, indeed, that the impression may have been left that computation is more complex than it really is, and the so-called 'short methods' not very short after all.

Part 1—general principles—covers the standard methods needed for estimation and tests of significance up to analysis of covariance, with an added chapter (the longest in the book) on the fitting of simple curves, which is mathematical rather than statistical, and which could with advantage have been integrated with the general study of regression. Part 2 deals with the design of field experiments, describing the ordinary arrangements up to simple factorial designs, including split plots, and giving consideration to experiments repeated in space and time. With some unnecessary repetition from Part 2, Part 3 rounds off the work with nine full-scale examples. It would have been a convenience to readers to point out that variance-ratio tables are available, with all the other tables required, in a single book, "Statistical Tables", by Fisher and Yates.

The main points of criticism are a need in some places for integration of alternative methods, a faulty comparison of a total and partial correlation coefficient on p. 57, and some confusion regarding the use of interactions in space-time experiments (for example, p. 177). But, in any event, sylviculturists will be safer with this book than with some of those given in the list of references, and the authors are to be commended for a useful compilation which will have a general value outside the forestry service.

J. Wishart

SURVEY OF THE GREAT WORLD RELIGIONS

Ethics of the Great Religions

With some Account of their Origins, Scriptures and Practices. By E. Royston Pike. Pp. viii+247+20 plates. (London: Watts and Co., 1948.) 15*s.* net.

THIS is an attractively illustrated and very readable book, but one which nevertheless cannot be altogether recommended as a reliable introduction to the subject. Any attempt to study the great world religions which treats them as, in essence, no more than a number of ethical systems, converging towards something like agreement, inevitably fails to do justice to the specific *differentia* of each particular religion.

A religion is more fundamentally a metaphysical than a moral system. Its ethical commandments and prohibitions are understood and justified by its votaries in terms of its metaphysic, and not the other way round. Religious morality is always a relative morality of adaptation to presumed circumstances, and never an absolute morality justifying itself in terms of belief in a conscience or capacity for moral intuition which functions independently of all metaphysical beliefs and presuppositions. Thus even when the ethical prescriptions of two different religions appear, when abstracted from their respective metaphysical contexts, to be in fundamental agreement, the appearance is, in fact, a misleading one. For example, one religion may cultivate asceticism because it distrusts personal life and selfhood, and wishes men to lull themselves into self-forgetfulness and resignation by the elimination of desire; whereas another may resort to ascetic disciplines for precisely the opposite reason, because it believes in personal existence and seeks to intensify its powers by discipline and concentration. The resemblance, in such a case, will be accidental and superficial; the differences are essential and profound.

The truth is that comparative religion is a subject most appropriately studied, because most sympathetically and with most insight, by a man of personal religious experience and conviction. To write about the observed phenomena of religion without knowing the inward discipline of 'being religious' is rather like trying to contribute to the progress of physical science without acquainting oneself with the laboratory techniques of controlled observation and experiment which it employs. It may be replied that the teacher who is a disciple of no one of the great world religions is more likely to display impartiality as between them all than, shall we say, a Christian teacher. But this is one of the great errors of so much liberal educational thought. The real virtue of the teacher is not impartiality—a quality which the mere dilettante can simulate easily enough—but justice, the stern intellectual self-discipline which enables a man who has committed himself utterly to the guidance and promptings of his own convictions to look with charity and understanding upon those of others. Thus a book like this fails to satisfy the Christian reader; but it fails equally, and for the same reasons, to satisfy the Moslem or the Buddhist. A Christian writer on the same subject would do justice to the specific *differentia* of Christianity; but at the same time, and as part of the same process, he would also render a similar service to Islam and Buddhism, and leave the Moslem and the Buddhist at all events less dissatisfied.

To the Christian the author's treatment of Christianity seems particularly defective—he shows, for example, no knowledge or even suspicion of the tendency and implications of recent discoveries in the realm of biblical criticism (he is "almost certain" that St. John's Gospel was not written "earlier than 100 A.D.")—but no doubt a Buddhist would feel that his account of Buddhism is his greatest failure, while a Moslem would complain in particular of a pathetic inability to penetrate the secret of the power of Islam. To be equally unjust to everybody is indeed a travesty of real impartiality; but it is often the fate of the secularly minded doctrinaire liberalism which, in the modern world, has brought the genuine liberal values of our culture into their present parlous condition.

J. V. Langmead Casserley

The Penrose Annual

A Review of the Graphic Arts. Edited by R. B. Fishenden. Vol. 43. Pp. xii+140+40+139 plates. (London: Percy Lund, Humphries and Co., Ltd., 1949.) 21*s.* net.

"THE Penrose Annual" is an old friend of all connected with the printing industry, and its return after an absence of nine years is very welcome. This, the forty-third volume, follows the well-established lines of its predecessors, which in some ways is a pity, because in the nine years elapsing between the appearance of Volume 42 and Volume 43 the printing industry has had experiences which should be recorded. And where more appropriately than in "Penrose's"? The record is desirable not only for historical reasons, but also because much valuable experience was gained in solving problems which arise in an industry in total war, and this should not be lost.

The Annual consists of its usual four parts—"General Articles", "Technical Articles", specimens of contemporary printing and advertisements; and each contributes to the usefulness and interest of the book as "A Review of the Graphic Arts", a usefulness which does not diminish as the years pass. The "General Articles" are concerned mainly with typography and design, illuminated by the outstanding contribution of H. J. Deverson, "Photography in Battledress". The "Technical Articles" cover a wide field, and give promise that there may be outstanding technical developments in the printing industry before long. The printing specimens, covering all the major processes, are excellent in quality and show that British printing is second to none. Anyone who has an interest in good printing and in the ways in which it is produced will find much enjoyment in this volume—now and in twenty years time. It is excellent value for a guinea.

If old friendship permits of frankness, it is to be hoped that one or two of the authors, before they make their contributions for Volume 44, will take a little time off from printing to read Sir Ernest Gower's "Plain Words". There is at least one paragraph in Volume 43 which is good enough for *Punch.*

Proceedings of the Aristotelian Society

New Series, Vol. 47: Containing the Papers read before the Society during the Sixty-eighth Session, 1946–1947. Pp. xx+300. (London: Harrison and Sons, Ltd., 1947.) 30*s.* net.

IT is not infrequently asserted that we are unable, these days, to 'afford' pure knowledge, that it is an intellectual luxury, that it should be strictly rationed, and so forth. Luckily, in addition to *ad hoc* protests against a view so shocking, there occur certain periodic implied reactions; the appearance of a new volume of the *Proceedings of the Aristotelian Society* is one of these, and deserves a special welcome.

There is little continuity to be discerned in this collection; indeed, it is scarcely to be expected; the value lies in its 'forge-like' character, wherein thought-stuff is hammered out, fashioned, tempered and annealed. For example, the president's address provides some teleological clothing for E. S. Russell's functional biology; another contributor presents an exceptionally sensitive view of the role of pain in creative activity, while further on we meet with a penetrating analysis of existentialism in terms (largely) of its historical background. Kierkegaard, typical of a 'crisis-philosopher', fastened upon the story of the immolation of Isaac a nineteenth-century reflexion of the extreme credal position assumed ages before by Tertullian. The last paper is a most interesting exposition of the tentative method of approach to logical definition. Thus, in these ways, and in many more, we are refreshed and stimulated; but above all, it is good to know that some people still ponder for pondering's sake, and for no other reason.

F. I. G. RAWLINS

The Making of Scientific Management

By L. Urwick and E. F. L. Brech. Vol. 3: The Hawthorne Investigations. Pp. x+225+8 plates. (London: Management Publications Trust, 1948.) 12*s.* 6*d.* net.

THE findings and interpretation of what are known as the Hawthorne Investigations, carried out in the United States for the Western Electric Co. at its Hawthorne Plant, are of great interest to all concerned with problems of industrial relations and productivity in Great Britain, where the human factor is frequently the decisive one with which management has to deal. These findings, however, have been presented in seven main publications, four of which deal directly with the research activities and their results, while the other three use certain aspects of those findings to illustrate wider industrial and sociological problems of our time, such as that of leadership in a free society. This volume draws freely on those sources, giving a connected critical account which should be welcomed by those to whom the original volumes (some of which are out of print) are inaccessible. It will give most managers a sufficiently detailed account of the investigations, even if perforce some of the stimulus and vitality of Elton Mayo's and T. N. Whitehead's original books are lacking; and the brief notes on the original volumes which are included will direct those who wish to study the findings in more detail to the appropriate source.

R. B.

Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1943–1946

By W. C. Moore. (Ministry of Agriculture and Fisheries, Bulletin No. 139.) Pp. vi+90+12 plates. (London: H.M. Stationery Office, 1948.) 2*s.* 6*d.* net.

THE number of plant diseases, or at least the measure of man's awareness of them, is constantly increasing. Mr. W. C. Moore records twenty-six new diseases and twenty-one new host records during the four years 1943–46. It is possible, however, that only one of these new enemies—bacterial canker of tomato—is likely to add a serious challenge to plant pathologists. The disease, caused by the organism *Corynebacterium michiganense*, has appeared on outdoor tomatoes, mostly in the south-east of England, where some of the outbreaks have involved the death of considerable numbers of plants. The bulletin, however, does more than record the appearance of new diseases; it also assesses the status of pathogens which are recognized already. There is a growing tendency for advisory plant pathologists to become more truly quantitative in their estimates of disease, and Mr. Moore draws freely from the reports of his advisory colleagues and other collaborators. Graphs show the comparative phenology of potato blight in Cornwall, Devon and Yorkshire. Maps show the present position of diseases which are extending geographically, such as red core of strawberries, bacterial canker of tomatoes, asparagus rust, onion smut, and grey bulb rot of tulip. The results of surveys of take-all of wheat, yellows of sugar beet, wart disease of potatoes, and *Didymella* stem-rot of tomato are also given.

It is not the function of this publication to give lengthy descriptions of plant pathogens ; but the text nevertheless includes useful notes on some of the more uncommon troubles. Citations of recent and relevant literature are very frequent, and several photographs of particular diseases are reproduced. The whole makes a very modern symposium of plant pathology in England and Wales, showing the success of control measures for some diseases, indicating the need for new methods of prevention or eradication for others ; it holds the balance between those troubles which are only of scientific interest and those which provide a serious incubus on crop production.

J. G.

Diseases of Cereals

By Dr. W. A. R. Dillon Weston. Pp. x+69. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1948.) 4*s*. net.

HOW cereal diseases can be recognized and controlled is shown in the twenty-six pages of this well-produced and generously illustrated book. The author, as advisory plant pathologist, has devised life-cycles, attractively illustrated by Miss Ann Murray, to demonstrate diagrammatically important stages in the lives of organisms causing cereal diseases, and the means by which they can be controlled. These are used with other drawings to illustrate accounts of diseases caused by fungi and other ailments of cereals. The improvement in crop health since seed disinfection became general is indicated.

This book will be particularly useful to farmers and students for whom it is primarily designed ; and practising plant pathologists will appreciate the clear and concise accounts showing how modern knowledge is used in controlling disease. M. D. G.

Five-Figure Tables of Natural Trigonometrical Functions

Prepared by H.M. Nautical Almanac Office. Pp. iv + 124. (London : H.M. Stationery Office, 1947.) 15*s*. net.

THESE tables were originally prepared in 1941 by the Nautical Almanac Office, at the request of the War Office, for use in survey calculations. In 1945 they were reprinted, but the present issue, dated 1947, is the first one to become available to the general public. They contain *natural* values only, and are intended to replace similar tables, published in 1924 (in Part 2 of the "Manual of Artillery Survey"), which provided *logarithmic* values of the same four functions. It should be emphasized that they are primarily designed for use with calculating machines and are of no great practical value unless such a machine is available.

There are two distinct sections, in the first of which, the auxiliary section occupying some thirty pages, values of the cotangent are given to five significant figures for every second of arc up to 7° 30′. The main table, comprising ninety pages, contains values of the sine, tangent, cotangent and cosine arranged semi-quadrantally for every ten seconds of arc. In the cotangent tables for the range 27–45°, six significant figures are available, there being five only for the remaining entries. Information supplied at the heading of each third of a page enables the range of the tables to be extended to 360° without difficulty, and as the tabular intervals are so small no differences are provided, as interpolation is not considered necessary.

A short list of minor corrections which have been incorporated since 1945 and another of errata noted after printing are appended ; the book is well bound and clearly printed. J. H. PEARCE

Reports of the Progress of Applied Chemistry

Vol. 31, 1946. Pp. 745. (London : Society of Chemical Industry, n.d.) n.p.

IT is unfortunate that, owing to circumstances over which the editors no doubt have no control, the "Annual Reports" for 1946 have appeared only in 1948. Taking into account the fact that the publication of a paper may involve a year's delay, most of the actual work described is from three to four years old.

Apart from this defect, the volume maintains the usual excellence of the series. It is divided into twenty-eight main sections, to which forty-seven well-known authors have contributed. In general, these sections follow the headings adopted by *Chemical Abstracts*. One interesting departure is noted: "Pest Control" is given a separate section of 19 pages with 173 references, thus showing the growing importance of the subject. The main sections are subdivided, making it easy for a reader to look up any subject in which he may be particularly interested. The references cover an extremely wide range, and include papers or patents which may easily be overlooked without such guidance.

The subject-matter, varying from the production of ammonium sulphate in Turkey to the solubility of carbon in molten copper and the disposal of kitchen waste, is too varied to enable even an indication of its nature to be given ; but it may confidently be stated that few readers can glance through this volume without catching sight of something of unusual interest. H. E. WATSON

Sequence in Layered Rocks

A Study of Features and Structures useful for Determining Top and Bottom or Order of Succession in Bedded and Tabular Rock Bodies. By Prof. Robert R. Shrock. Pp. xiii+507. (New York and London : McGraw-Hill Book Co., Inc., 1948.) 45*s*.

THE use of features such as graded bedding and cross-lamination, pillow lavas and pipe amygdales, to establish the order of succession in a series of folded strata is but briefly dealt with in text-books of geology. Prof. Robert R. Shrock sets out to describe and illustrate not only these better-known top and bottom criteria, but also all other features, structures and relations which have been or might be employed in determining the original order of succession in sedimentary, igneous and metamorphic rocks. His comprehensive compilation is a work of quite a new kind which can be used with advantage to supplement existing texts of a more general nature. While prepared specifically for students, it will form a valuable review for experienced field geologists, who will undoubtedly find it most stimulating. The illustrations comprise some 500 line drawings and more than 150 photographs, nearly all of which are new to text-book literature. A bibliography of seven hundred items is drawn principally from American and British publications.

COUNT RUMFORD AND THE FOUNDING OF THE ROYAL INSTITUTION

By THOMAS MARTIN
General Secretary, Royal Institution

A HUNDRED and fifty years ago, on March 7, 1799, a meeting was held at the house of Sir Joseph Banks in Soho Square, London, to consider proposals for founding a new scientific institution in London. The gathering in Sir Joseph's principal room or council chamber included a number of peers, members of Parliament and public men, with others distinguished for their scientific attainments or well known for their charitable and philanthropic activities. Those who had been called to the meeting were the contributors of fifty guineas each in response to an appeal "for forming by subscription, in the Metropolis of the British Empire, a Public Institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life".

The founders of the new institution had gone far towards ensuring the success of their enterprise by enlisting the help of Sir Joseph Banks, the all-powerful president of the Royal Society. Such was his influence in all scientific matters at this time that it is doubtful if they could have succeeded had he opposed their plan. As it was, he presided at the meeting, the proposals, which had been printed and circulated, were adopted, and it was resolved to petition His Majesty King George III for a royal charter. A committee of managers was appointed and requested "to take preparatory measures for opening the Institution". Thus by resolution of this original body of proprietors, the Royal Institution of Great Britain, as it was afterwards named in the charter, came into existence.

Sir Joseph presided at the early meetings of the managers, which were held almost weekly at this time, and the Royal Institution owes much to his sponsorship and encouragement; but for the true inspirers and originators of the project we must look in a less obvious, and somewhat unexpected, direction. Among the subscribers who attended the original meeting were William Wilberforce, Thomas Bernard and Count Rumford. Wilberforce, the member of Parliament for Yorkshire, was the great advocate of the abolition of slavery. Thomas (afterwards Sir Thomas) Bernard was the treasurer of the Foundling Hospital. Sir Benjamin Thompson, Count Rumford, was that remarkable soldier, statesman and man of science who had been born in America and had come to England during the War of Independence: he had recently returned to this country after a long period in high office under the Elector Palatine of Bavaria. Only one of these three, Rumford, had scientific attainments to account for his interest in the new institution; but all were actively engaged in humanitarian and philanthropic enterprises, and in particular were associated in the affairs of a society called the Society for Bettering the Condition and Increasing the Comforts of the Poor.

Rumford, whose title as a Count of the Holy Roman Empire had been conferred on him by the Elector Karl Theodor, had spent the most active and fruitful years of his career in Bavaria. It was in Munich that the greater part of his scientific work on heat had been carried out, including his well-known experiment on the source of the heat excited in the boring of cannon at the Arsenal; but his experiments were by way of relaxation, in a life fully occupied with military and administrative duties. In these he had shown great enterprise and versatility, providing the firm hand which was sorely needed by the Elector in the government of his country. Bavaria was suffering from the ravages of war, there was corruption in high places and poverty and lawlessness among the people. Gangs of beggars and vagabonds, many of them ex-soldiers, roamed the country, converging on Munich, where they systematically extorted alms from the more law-abiding citizens.

The state of affairs had become intolerable, and after much consideration Rumford devised a plan, which with the aid of the military he put into operation on New Year's Day, 1790, for arresting all the beggars in the city. The able-bodied were put to useful work in 'houses of industry' and the infirm given alms from funds subscribed by the citizens. Thereafter begging was prohibited. By his humane and enlightened methods with the poor people and his care in the administration of his 'institutions for the poor', Rumford succeeded in making his system work and in ridding Munich of its incubus for a considerable period of years.

He became much interested in the problems of practical philanthropy, and devoted attention to such matters as economy of fuel, the design of stoves and fireplaces, the improvement of cooking utensils and the preparation of nourishing food at a minimum of cost. The fame of his methods spread to other countries, and he was consulted everywhere on the economy of establishments for the poor. 'Rumford soup kitchens' and 'eating houses' were set up in many places. In London he advised on the arrangements at the Foundling Hospital. Its treasurer, Thomas Bernard, was a particular admirer of his methods, and in 1796 proposed the formation of a society to promote their introduction into Britain. The society thus established, with the active co-operation of Wilberforce and other philanthropists, was the 'Bettering' Society mentioned above.

It was naturally with his friends in the Bettering Society that Rumford discussed a particularly cherished scheme, that of an institution to be devoted to the application of science and invention to the improvement of the lot of the poorer classes; and early in 1799 the Society launched the appeal which, as we have seen, resulted in the formation of the Royal Institution. The Bettering Society was thus the precursor of the Institution; but Rumford early decided that this new establishment was too interesting and important to be merely an appendage of another society. In the proposals, therefore, which he drew up himself, and in which its objects were described in great detail, it was given a separate constitution; and as he worked on the scheme its magnitude and its possibilities grew in his eyes. Before long the house in Albemarle Street, which the Institution still occupies, was purchased; and the royal charter was duly granted by the King. At the request of the managers, Rumford went to live at the house, so that he could personally supervise every detail of the arrangements, and for two years this became his principal occupation.

A special feature of the Institution was to be the Repository or Model-room in which working models of new inventions were to be exhibited. There were to be fireplaces, stoves and kitchen utensils of the latest design. A complete kitchen was to be equipped, from which meals would be served to the proprietors. Workshops would be established and classes held for the instruction of artisans and mechanics. The speedy introduction of all useful mechanical inventions and improvements was to be one of the two principal objects; the other was the application of science to the improvement of arts and manufactures, and for this purpose a lecture room and laboratories would be provided, professors and lecturers engaged, courses of philosophical lectures would be given and chemical and other experiments carried out. For the management of the Institution there were to be committees of managers to govern and direct, and 'visitors' to inspect and audit, responsible to the proprietors, whose interest was hereditary.

For a time the efforts of the early managers met with much success. The ninth Earl of Winchilsea became the first president; the nobility and gentry, the philanthropic and the learned, gave their support as proprietors or subscribers. The lecture theatre, now famous as one of the best for its purpose in existence, was built, the model room, laboratories and workshops constructed and equipped, and the library and reading-rooms opened to the proprietors. Dr. Thomas Garnett, from Anderson's Institution in Glasgow, was engaged as the first professor, and courses of lectures were begun.

This was the Royal Institution as it was originally conceived, and although there have been great changes, those who know it will recognize much that has survived to the present day. It was Rumford's plan, and in the early years his ideas were closely followed. He is rightly regarded as the founder; although by some a share at least of the honours has been claimed for Sir Thomas Bernard.

After a time, however, differences of opinion arose. Rumford quarrelled with Prof. Garnett, and he fell out with some of the other managers, who found him dictatorial and overbearing. Not all of them were in sympathy with his philanthropic ideas or believed that the poor and the working classes in Britain would respond to the methods he had found successful in Bavaria. Moreover, the plan for the Institution proved too ambitious and expensive and had to be curtailed. Rumford began to lose interest; he went off to the Continent again, intending to return; but, in fact, he stayed in Paris to marry the widow of the great French chemist Lavoisier.

The control of the Royal Institution fell into other hands. The new managers quietly dropped the classes for mechanics, the cooking and kitchen economy, and other features of Rumford's plan, and endeavoured to popularize the establishment with those to whom it looked for financial support by arranging courses of lectures on popular science, literature and the arts. Sir Joseph Banks in London grumbled by letter to Rumford regretting his absence, telling him that the Institution was "now entirely in the hands of the profane" and declaring that he would have nothing more to do with it.

But the changes which now took place were due not so much to acts of the management as to the activities and growing reputation of Humphry Davy. Before he left England, Rumford had engaged this young man from Bristol as lecturer in chemistry. Thomas Young had succeeded Garnett, and for a time Young and Davy worked together. Later, Davy became the professor of chemistry, and it is well known how his gifts as a lecturer and his brilliant researches on the chemical action of electricity established both his own reputation and that of the Institution. Scientific research and exposition became the order of the day.

This alteration of purpose was frankly recognized by an Act of Parliament in 1810, which amended the constitution of the Institution, extending its objects to include the "promotion of chemical science by experiments and lectures" and the "diffusion and extension of useful knowledge in general", and substituting for the hereditary proprietors, who were compensated and dispossessed, a body of elected members. Constitutionally, the Royal Institution as we know it to-day dates from the Act of 1810; but its character and traditions were established by the brilliance of Humphry Davy, to be maintained and enlarged by the genius of his assistant and successor, Michael Faraday.

At this hundred and fiftieth anniversary, however, we celebrate the founder, Benjamin Thompson, Count Rumford. He made probably his greatest contribution to its success when he brought Humphry Davy to work in his Institution; and if it is something of a changeling from the establishment he originally intended, none will now deny him credit for the importance of his achievement or its significance in the history of science.

FOREST RESOURCES OF THE WORLD

A SMALL booklet has recently been issued by the Food and Agriculture Organisation of the United Nations, Division of Forestry, entitled "Forest Resources of the World" (Washington, D.C., 1948). This report is of first importance and interest, and discloses the steps which have been taken to have a real inventory of the world's forestry resources prepared, a piece of work far more difficult of achievement than might be supposed. This difficulty is due to the fact that a considerable proportion of the forests of the world are still without any really proper and efficient management. Consequently, any figures obtained on the subject of the abundance or otherwise of their several resources can, in certain cases, be accepted only with reserve.

The report commences with the question as to whether or not man will be compelled to resign himself to a perpetual shortage of forestry products. To this the report's answer is 'No', and this reply applies to a still larger population than at present exists. It will be of interest to follow the argument which, of necessity, must be based to a considerable extent on the still untapped forests of the world.

From earliest times a large section of the world's population has depended on the forest—at first for fuel only, then for timber for house construction, farm implements and so forth. The introduction of more modern forms of building, it was said, would see the importance of timber decrease and, therefore, the people's corresponding dependence on the forest. The reverse has been the case. The modern industrial age has brought with it new demands on wood for direct use in manufacturing industries and for making the crates and boxes which protect these products in transit. The extraordinary, and certainly not foreseen, development in the uses of wood pulp during the past century has made the forest the primary source of most of the world's paper and of a substantial proportion of its textiles. Wood chemistry is constantly developing entirely new products derived from wood. How great are these increased demands and what bearing have they on the existing forests and possibly newly created forests in the world ? For one thing, there is no longer the sharp distinction of utilization which formerly existed between the conifers and the hardwoods. Hardwoods are now converted and used in industry for purposes for which originally only the conifer was considered suitable. This is to the good; and modern machinery and research have made it possible to utilize some of the hardwood species of the mixed tropical forests previously regarded as valueless for commercial and, therefore, sale purposes. Incidentally, this will facilitate the sylvicultural working and management of some of these forests. The other advance which it is imperative should be made is to put an end, in the interests of the world community and not only of those of one particular country, to lumbering in all its forms, with its aftermath so often of bad erosion and destruction, the starting of fires in the debris on the lumbered area, and their spreading into valuable standing forests and often into townships and villages. In this respect the waste in some parts of the world has been enormous; and yet the method still continues in the interests of the few. Less spectacular, but equally serious, is the continuing practice of the removal of forest growing on true forest soils in order to make room for poor and unproductive farms; in the tropics vast areas of forest have been degraded or entirely destroyed by the cycle of shifting cultivation and annual firing followed by excessive grazing, leading to the production of desert condition. With the balance of Nature upset, anything may happen: erosion and loss of valuable top-soil, lowering of water-levels in the soil, floods and devastation caused by such at the lower land-levels.

The first essential steps to ensure the future forest reserves is for the nations to get together and determine the measures required to stop general forest destruction throughout the world. The forester responsible for the well-being and management of the respective forest areas, and the timber and other merchants who extract the varied commodities from the forest and take them to the market, will then all be in a better position to gauge the maintenance of the forest resources position.

A first attempt at a solution was made by Dr. Raphael Zon and Mr. William A. Sparhawk in the United States immediately after the First World War. Their publication of 1922 was followed up by further efforts on the part of Finland and Sweden and by the International Institute of Agriculture at Rome, which published estimates supplied by national Governments in year-books between 1933 and 1948. In 1946, available information on the world's forests was summarized in a report submitted to the second session of the Conference of the Food and Agriculture Organisation under the title "Forestry and Forest Products—World Situation 1937–1946". In the same year, Sir Hugh Watson made a study which appeared in the "British Empire Forestry Handbook".

All these attempts suffered from the inevitable chief drawback—the lack of reliable forest-inventory information, coupled with the lack of common forestry definitions.

How far has this deterrent affected the present publication ? At the first session of the Conference of the Food and Agriculture Organisation in the autumn of 1945, the need for knowledge of the forest resources of the world was recognized. Later, it was decided to issue a draft questionnaire to all countries, only questions essential to an appraisal of the forestry situation in each country being included. The preparation of such a document would not appear to offer much difficulty. But the reality was far different. Quite apart from the diversity of forestry definitions, all sorts of other difficulties had appeared, and the final form of the questionnaire was not approved until the meeting of the third session of the Conference at Geneva in August 1947. Even in that final form it was obvious that difficulties, if not ambiguities, remained; for example, for tropical countries, the filling up of such a form for a province in India, with its regulated forest-management extending over a period of eighty years, as compared with one of the South American States where forestry management has scarcely made an appearance.

Herein lies the danger of an attempt to draw up inventories of forestry resources which are based on world figures designed to form a basis for world production and for utilization for a world population, the growth of which in relation to the use of the forest resources available cannot be correlated. A census of the total world population is possible. But attempts at a similar census of the world's forestry resources, given our present actual knowledge of many of the last remaining forestry areas, as, for example, in the Latin American States, or the large area of forest in northern Russia and Siberia, must inevitably detract from the value of world figures. On the other hand, those figures obtainable for the comparatively small area of forest under a high or even modified forestry management will prove sufficiently accurate; but it is dangerous to take estimates based on such figures and apply them elsewhere to forests of which little is known. This has failed before. It is for similar reasons that calculations of the growth and volume of timber to be derived from plantations made on previously bare unafforested lands are likely to be incorrect.

Nevertheless, both the work and the information we have in this booklet are invaluable. At last the difficulties have been clearly seen and thoroughly grasped. Such items as land classification, classification of production forests, land ownership and volume of growing stock, all of them apparently simple divisions of the subject, produced divergencies of interpretation and meaning. Official statements respecting the forest resources of 101 countries and non-self-governing territories were received up to the date of publication. Additional questionnaires were expected, but the widespread interest aroused by the inquiry was considered to justify the publication of the present booklet. The tabular statements are ten in number and are entitled, respectively: response to inventory questionnaire; forested areas of the world; classification of productive forests; land classification; classification of productive forests, contd.; ownership of productive forests; growing stocks in accessible productive forests; average annual growth and annual drain for all species, for conifers only, for broad-leaved forests, respectively.

From the figures obtained, the authors of the report state that the forests of the world are capable of providing "reasonably adequate supplies" to a population larger than now exists. "But," they write, "the provision of such supplies will entail treatment of all productive forests as renewable crops, opening up of forests which are not yet accessible, and cessation of the widespread devastation of forests which, in this twentieth century, still continues."

If this is to come about, Governments, and their responsible ministers, finance members and treasuries, will have to regard the forest and its management as a very different proposition from that envisaged in the past. With the Governments responsible must be included large masses of the populations existing on the globe to-day; for without their intelligent co-operation in forest protection and management, inventories of forest resources may prove misleading and even dangerous. E. P. STEBBING

NON-UNIFORMITY OF THE EARTH'S ROTATION AND GEOMAGNETISM

By PROF. W. M. ELSASSER
University of Pennsylvania

THE existence of a secular deceleration of the earth's angular velocity at a rate

$$d\omega/dt = -2\cdot5 \times 10^{-22} \text{ sec.}^{-2} \qquad (1)$$

has long been established from astronomical data[1]. The classical work of G. H. Darwin and of Jeffreys, culminating in Jeffreys's computation of the frictional torque of the oceanic tide, seemed to have settled the theoretical aspects of the problem[2]. Later, de Sitter[3] and Spencer Jones[4] re-investigated the astronomical data. The value (1) is based on data from ancient eclipses and represents the average deceleration over the last two thousand years. Observations of the longitude of the moon, sun and planets over the past two hundred and fifty years show that the mean deceleration during this time was smaller than (1) —according to de Sitter 60 per cent, according to Spencer Jones 35 per cent of (1). Both the ancient and modern data seem trustworthy, and the conclusion is that a change in deceleration during the historical age is most probably real. Quite recently, it has been necessary to reopen the question as new geophysical information has become available. It can now be said that in all probability the deceleration of the earth is produced by two independent agencies: the oceanic tide, and a still very obscure effect in the earth's liquid core. While nothing is as yet known about the dynamics of motions in the core, there is good reason for believing that an appreciable fraction of the retarding torque operates in the core rather than in the oceans. This is perhaps close to the original ideas of Darwin, but the observations that lead to this conclusion are novel.

Let us first give a brief idea of the mechanics of the deceleration. We shall ignore the small solar tide as compared to the lunar tide. The angular momentum of the system earth–moon must be conserved. Darwin and Jeffreys have shown that the orbital motion of the moon takes up the angular momentum lost by the earth; the moon gradually recedes from the earth. Now the ratio of energy to angular momentum for the earth's rotation is $\frac{1}{2}\omega_e$; the same ratio for the moon's orbital motion is $-\frac{1}{2}\omega_m$. But $\omega_e/\omega_m = 28$, and it follows that per unit angular momentum transmitted to the moon, only 1/28 of the rotational energy of the earth is transmitted; the remainder must be used up by friction or other transformations of energy in the earth. The frictional forces produce a couple that retards the earth, and at the same time a force acts on the moon, tending to push the latter away from the earth. One of the more gratifying features of this theory is the fact that the observed deceleration is of the right general order to account for a gradual removal of the moon from an original position very close to the earth to its present distance during the known life-time of the earth.

The new evidence arises from rather unexpected quarters; it is based on geomagnetic observations. As we have endeavoured to show[5], the secular variation of the geomagnetic field can be explained by means of motions of the matter in the earth's fluid metallic core. Such motions induce electric currents in the core, of magnitude $I = \sigma v \times B$, where σ is the conductivity, v the velocity of the fluid, B the existing magnetic field. Bullard[6] has recently come to identical conclusions; he has, moreover, applied these principles to a study of the secular variation, with promising results. In general, an electromagnetic field in the presence of internal motions in a fluid conductor is non-conservative; energy is being exchanged between the field and the motion of the fluid. On the other hand, it can be shown[5] that so long as a parcel of the fluid moves without deformation, or if its deformation is negligible, it carries its electric currents and magnetic field with it unchanged except for the free decay of the currents. One immediate consequence of this is the fact that the observed irregular magnetic field rotates with the earth. Another important consequence will be indicated below.

We have recently come into possession of a most remarkable set of world-wide maps of the secular geomagnetic variation, constructed by Vestine and his collaborators[7]. These are based on an exhaustive evaluation of magnetic data and cover the period 1912–42 in intervals of ten years. The maps show that there are a number of centres of the secular variation scattered about the earth; these centres undergo rapid changes of intensity and also displacements of their position. The similarity of these maps and of ordinary weather charts is amazing, and there is no better way of conveying the idea that the secular variation owes its origin to fluid motions in the core than a contemplation of these maps. There are two independent ways in which the velocity of the fluid can be estimated, first by direct inspection of the displacement of the centres, and secondly from the rate of change of the field, using the electromagnetic theory[5,6]. Both methods give velocities of about 0·1–1 mm./sec. The most interesting feature, however, exhibited by these maps is a general *drift* of the whole pattern of the secular variation in the direction from east to west. It is difficult to assign an exact numerical value to this drift motion, since it is superposed upon the irregular displacement of the centres and is of the same order of magnitude as the latter. In order to have a convenient figure, we may estimate a value of 0·5°/year, which at the equator of the core represents a linear velocity of

1 mm./sec. Since this corresponds to an overall displacement of 15° over the period of thirty years covered by Vestine's maps, it is clear that the westerly drift is a conspicuous effect. There can be no doubt as to its reality. It occurred to us that if such a mean motion exists, it might not have escaped the attention of earlier students of the secular variation. In fact, Bauer[8] stated in 1895 that he found a "westerly wave" of the secular variation, and he traces it back to the middle of the sixteenth century. The mean angular velocity, so far as can be seen from his data, seems about half the value given above. The cause of the discrepancy is not clear; it is, no doubt, connected with the great irregularity of the secular pattern. Further corroboration of the effect may be found in the analysis of magnetic data of the sixteenth and seventeenth centuries by van Bemmelen[9].

On the basis of the theory which explains the secular variation as the result of fluid motions in the core, these observations must needs be interpreted as representing a bodily displacement of the core in the direction from east to west. This result agrees with the above-mentioned theorem, that the magnetic field is carried along unchanged if a bodily displacement of the conductor occurs. In spite of great efforts, we have been unable to devise any other even remotely satisfactory interpretation of the phenomenon. It will be noted that the direction of the drift is such as to indicate a *lag* of the core behind the rotation of the earth. This is the opposite of what one would expect if the earth were decelerated by a frictional torque in the oceans. From quite elementary considerations of mechanics one would expect the core to rotate faster than the mantle. The difference in angular velocity would be determined by the amount of eddy friction at the boundary of the core. Considering the magnitude of the velocities inferred from the secular variation, it seems likely that a turbulent boundary layer does exist at the surface of the core. (This view differs, however, from that of Bondi and Lyttleton[10], who assume laminar flow.)

Our first and natural reaction would be to try to explain away the phenomenon. As already noted, it would be practically impossible to explain it as due to cumulative or systematic errors in the observation. Students of meteorology might be reminded of the belts of alternating easterly and westerly winds which are a well-known feature of the atmosphere, and which adjust themselves so that the mean torque between the atmosphere and the solid earth vanishes. A careful study of Vestine's maps has not revealed any indication of an opposing drift motion; the existing westerly drift seems rather evenly distributed over the whole earth. Again, one might think that the present condition of the core is in the nature of a temporary deviation from its average state. If we assumed that there is no oceanic tide and that the core alone is decelerated at the rate given by (1), it is readily found that it takes 22,000 years to build up a difference in angular velocity of 0·5°/year. Since the mean life-time of the centres of the secular variation is much smaller—a few hundred years at the most—it seems well-nigh impossible to interpret the westerly drift motion as a mere fluctuation.

Hence we must conclude that the earth's core actually rotates more slowly than the solid 'mantle' surrounding it. It follows at once that, owing to eddy friction at the boundary of the core, angular momentum migrates from the mantle into the core. The core must continuously lose angular momentum, and this is impossible unless there is a direct gravitational interaction between the core and the moon such that the angular momentum lost can re-appear in the orbital motion of the moon. Perhaps the interpretation of these results is facilitated by the recent discovery[10] that the core is not homogeneous but contains a central body of as yet unknown constitution. This is indicated by the peculiar behaviour of seismic waves at great depths. The boundary of this central body seems the natural locus of any tidal effects in the core.

It is one of the results of the theory of tidal friction that the dissipation in deep seas is negligibly small. The frictional effects of the oceanic tide computed by Jeffreys[11] arise in shallow basins such as the Bering Sea, the Irish Sea, etc. It is in the nature of such a theory that no great numerical accuracy can be expected from it. We have just indicated that in place of one retarding couple acting on the earth there are two, one in the oceans and one in the core. It is difficult to estimate the relative magnitude of the two, as Jeffreys's theory of tidal friction can scarcely afford a quantitative clue. The moment of inertia of the core is about one tenth of that of the earth. Hence if the 'inner' couple decelerated the core alone, and the 'outer' couple acted on the mantle alone, their ratio would be 1 to 10. Since, however, angular momentum migrates into the core, the inner couple must actually be larger. Just what fraction of the whole retarding torque it constitutes can only be said when it becomes possible to estimate the magnitude of the eddy friction at the boundary of the core. Given the great variability of the secular magnetic field and the inference from it that the motions in the core are highly unstable, an explanation of a change in the earth's deceleration might well be sought along these lines rather than by the assumption of a change of friction in the oceanic tide.

The existence of the westerly drift motion throws an entirely new light on the physics of the earth's interior. It strongly corroborates the theories which connect the phenomena of geomagnetism with fluid motions in the core, in that it reveals the existence of a supply of power for the maintenance of such motions throughout the life of the earth. It has been shown[5,6] that the magnetic field in the interior of the core must be much stronger than the field at the outside, and the energy of this internal field is supplied directly by the fluid motion. Numerical estimates make it appear possible that the conversion into magnetic field-energy replaces mechanical friction in the core as the agent productive of the retarding torque. Whatever the ultimate outcome of these theories, it seems certain that the discovery of the westerly drift motion by Vestine opens up a new branch of geophysical dynamics.

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OBITUARIES

Dr. H. J. van der Bijl, F.R.S.

Dr. Hendrik Johannes van der Bijl, whose death occurred on December 2, was born in 1887. From early childhood he showed that he was of stern stuff and would be different from others. A successful stay at the University of Stellenbosch concluded with a B.Sc. honours degree. He proceeded to Germany, where, at the University of Halle, he obtained the degree of M.A., to be followed later on by the Ph.D. of the University of Leipzig. It was while he was instructor in physics at the Royal School of Technology at Dresden that he came in contact with Prof. R. A. Millikan, who had gone to Germany to deliver a lecture on an aspect of physics with which van der Bijl was also dealing at the time; this meeting laid the foundation for van der Bijl's meteoric career. So impressed was Prof. Millikan that on his return to the United States he advised the Western Electric Company, New York, to employ the serious young South African to pursue research on the triode, which had recently been invented by Lee de Forest, and was just being applied in the fast-developing art of radio.

Van der Bijl's success was remarkable; it came as the result of an indomitable will to accomplish and an uncanny insight into the workings of thermionics, which he had made his special study in Germany. His promotion was deservedly rapid, and he would undoubtedly have left an even greater mark in the United States had he not lent an ear to the cry of his native land in the person of General J. C. Smuts.

So he became technical adviser on industrial development to the Department of Mines and Industries of the Union of South Africa. Apart from a new Weights and Measures Act, he busied himself in the preparation of the proposed Electricity Supply Act of 1922. Like the slumbering industrial giant in the United States which was first awakened by the First World War, so the Union of South Africa was activated from her slow farming and easy gold-mining economy into the first gropings for an industrial economy. Fortunate indeed was it for the Union that it had van der Bijl, with his great natural gifts and unique technical training, his insight into the future, his willingness to dare, his determination to succeed and his genius for planning.

The establishment and success of the South African Iron and Steel Corporation followed in 1928, and by 1947 he had sponsored and developed numerous other projects.

Van der Bijl's early scholastic attainments have already been mentioned; in addition he held the honorary degrees of D.Sc. of the University of Stellenbosch and LL.D. of the University of Cape Town. He was a member of the American Institute of Electrical Engineers, fellow of the Institute of Radio Engineers, fellow of the Royal Society of South Africa, honorary member of the Koninklyk Instituut van Ingenieurs (Holland), foreign associate of the U.S. National Academy of Science, and fellow of the Royal Society. He was also chancellor of the University of Pretoria. He was the author of a large number of scientific and technical works in German and English published in Germany, America and South Africa. His book, "The Thermionic Vacuum Tube, and its Applications", published in 1920, was at the time the best of its kind in the English language.

His industrial career includes a long list of successful chairmanships and directorships. At the time of his death he was chairman of the Electricity Supply Commission, of the South African Iron and Steel Corporation, chairman and managing director of the African Metals Corporation, Ltd., and of many other bodies. As director-general of war supplies and, later, director-general of supplies during the Second World War, he continued and nursed on the road to completion the industrial development of his homeland, which as technical adviser he helped to initiate in 1920. It is worth recording that the British Government consulted him on its proposed bill for the nationalization of the steel industry in Britain.

The confidence South Africa had in his integrity and ability was remarkable, and he inspired all with whom he came in contact with his ebullient optimism and dynamic activity. In the endeavours for the success of his undertakings it was a fight to glorious victory—or destruction. His end came on December 2, at the peak of his career; he was utterly exhausted by a full and exacting life and by a merciless illness.

J. Theo. Hattingh

Rev. J. P. Rowland, S.J.

We regret to record the death of Father James Peter Rowland, until recently director of Stonyhurst Observatory. Father Rowland was a native of Blackburn, born on June 29, 1875; he was educated at Mount St. Mary's College, near Sheffield, and joined the Society of Jesus in September 1894. In October 1919 he was appointed assistant at Stonyhurst Observatory, and became its director in 1932. He was a member of several learned scientific societies, including the Royal Astronomical and Royal Meteorological Societies.

To the general public, especially in East Lancashire, Father Rowland was known chiefly for his weather forecasts, which were published in the local evening papers, and gained a high reputation for accuracy. To the scientific world, however, his work in seismology was of more importance. Considering, indeed, the limitation imposed by a single Milne–Shaw instrument and the difficulties of the situation, Father Rowland's work was remarkable for its accuracy, and won for him a position among the seismologists of Great Britain. He had two notable successes, in the location of the epicentres of the North Sea earthquake of 1931, and the Wensleydale earthquake of 1933, on the latter of which he read a paper before the British Association.

His other work at the Observatory included the routine magnetic observations, the routine solar observations and occasional astronomical work. All these were remarkable for their accuracy, attained in many instances in spite of the difficulties in the accurate use of old-fashioned instruments. It is to be regretted that there is so little published matter connected with his name. In 1933 he published in the *Monthly Notices of the Royal Astronomical Society* the results of his observations of the period of rotation of the planet Saturn, which probably give the value of this as definitively as is at present possible. There are two papers in his name in the *Monthly Notices* on solar and magnetic work, and during his directorship of the Stonyhurst Observatory he was responsible for the Observatory's Annual Report; but apart from these, his publications are no more than brief notes. Nevertheless, in the course of years of routine observation, especially on sunspots and terrestrial magnetism, he amassed a quantity of material which it is hoped will one day be subjected to profitable analysis.

As a man, Father Rowland had great charm of manner and made many friends, and there was a whimsical mournfulness about him which never failed to amuse those who knew him intimately. He took endless pains to answer the queries of those who wrote to him for information, and in his priestly work was a zealous and sympathetic helper of souls. Towards the end of his life he became rather prematurely aged and enfeebled, and, at the close of 1947, had to retire from all active work. The end came sooner than was expected. He collapsed and was taken to hospital on December 19, and died rather suddenly on the morning of December 26.

WE regret to announce the following deaths:

Prof. C. O. Bergstrand, formerly professor of astronomy in the University of Uppsala, on September 27, aged seventy-five.

Prof. Torsten Carleman, professor of mathematics in the University of Stockholm, on January 11, aged fifty-six.

Prof. Walter Garstang, emeritus professor of zoology in the University of Leeds, on February 23, aged eighty-one.

Prof. Douglas Hay, chief mining engineer (management) of the National Coal Board and president of the Institution of Mining Engineers, on February 24, aged sixty.

Prof. Richard C. Tolman, of the California Institute of Technology, vice-chairman of the U.S. National Defense Committee, on August 14, aged sixty-seven.

NEWS and VIEWS

The Crisis in Soviet Science

LAST August scientific workers all over the world heard with deep disappointment that the Soviet Union had officially adopted an isolationist attitude on certain branches of biology. For the first time in the U.S.S.R. there was established a 'party line' in one of the natural sciences. Since then there has been speculation as to whether this attitude might extend to other natural sciences, and a recent broadcast from Moscow gives point to these speculations. On January 26, 1949, the philosopher Alexander Alexandrovitch Maximov, who is a corresponding member of the Academy of Sciences, and who belongs to the staff of its Institute of Philosophy, gave a broadcast on the Moscow Radio Home Service. The theme of his talk was the correct Bolshevik attitude to natural science. He attacks those foreign physicists who "regard as synonymous the philosophical definition of matter and the objective idea of reality", and who are responsible for other "idealistic misinterpretations" in relativity and quantum theory. He indicts by name Einstein, Niels Bohr and Heisenberg. He warns his listeners against the "Kantian acrobatics of modern bourgeois atomic physicists". He contrasts the ideology of these "social traitors" in capitalist countries with the scholars in capitalist countries who "raise their voice in support of genuine science, of a scientific materialist outlook"; and he cites with approval Langevin, Joliot-Curie, Blackett, Haldane and Levy. The purpose of the broadcast was twofold: (*a*) to emphasize the importance of a correct philosophical approach to physics, based on Lenin's famous "Materialism and Empiriocriticism", and (*b*) to encourage an attitude of "militant intransigence towards bourgeois idealistic philosophy and sociology".

Botany at Bangor: Prof. D. Thoday, F.R.S.

PROF. D. THODAY retires from the chair of botany at the University College of North Wales, Bangor, on September 30. After graduating at Cambridge, he carried out researches on photosynthesis under the late Dr. F. F. Blackman before going to the University of Manchester as lecturer. Thence he became professor of botany at Cape Town in 1918 and returned to Bangor in 1923. Prof. Thoday has successfully combined arduous teaching duties with active research, in which he has made notable contributions in several fields—the water-relations of plants, plant development and differentiation, and the physiology of succulents. In South Africa he was much interested in the native plants, and several of his investigations concern them; in this connexion he revised the genus *Passerina*. He was president of Section K of the British Association meeting at Dundee in 1939, when he gave a stimulating address on the interpretation of plant structure.

During his tenure at Bangor, Prof. Thoday has seen great developments in his Department, for which he has been chiefly responsible. New laboratories were built in 1926; but these were already congested by 1939 when, owing to the War, accommodation had also to be found for the botany students and staff of University College, London. The latter are grateful for his assistance at a critical time. Plans are now under way for a new building to house the Departments of Botany and Forestry. At Bangor there is intimate contact between these Departments and also that of Agricultural Botany, which Prof. Thoday has greatly fostered, especially as regards instruction in plant physiology and ecology. His staff have made important contributions to the ecology of North Wales and to the algal floras of the area. He has warmly supported Prof. Brambell's plea for a marine biological station on the Menai Straits, now happily being brought to fruition. Both as dean of the College faculty of science and in other ways, Prof. Thoday has taken an active part in College and University administration. On retirement, Prof. Thoday hopes to publish his researches on the developmental physiology and morphology of the mistletoe (*Viscum album*), on which he has been engaged for some years, and to carry out further investigations on other members of the Loranthaceæ in South Africa and elsewhere.

Prof. P. W. Richards

DR. P. W. RICHARDS, university lecturer and former fellow of Trinity College, Cambridge, has been appointed to succeed Prof. Thoday in the chair of botany at Bangor. His chief interests are in plant ecology and the Bryophyta, and he will have abundant opportunity for their pursuit in one of the richest regions of Great Britain for such studies. Dr. Richards has been a valuable member of the staff of the Cambridge Botany School since 1937, where he has been responsible for the organisation of the practical classes for first- and second-year students and has taken a principal part in lecturing to them. A noteworthy feature of his teaching has been his wide outlook and his insistence on the study of plants in the field; in this connexion he has conducted many vacation classes in the Lake District and elsewhere. He is one of the editors of the Ecological Society's "Biological Flora of the British Isles", and has encouraged much research on interesting plants.

Dr. Richards has travelled extensively in connexion with his studies of tropical rain forests. In 1929 he was in British Guiana, in 1932 he visited Sarawak, and during 1934–35 and 1947–48 he was the leader of Cambridge botanical expeditions to Nigeria. In addition to publishing papers on various aspects of tropical rain forests he has written a comprehensive book about them, now in course of publication. As a bryologist, Dr. Richards is outstanding, and he is convinced that mosses and liverworts offer a favourable field, hitherto largely unexplored, for experimental studies. He has taken great interest in the Cambridge Botanic Garden. His Cambridge colleagues, while regretting Dr. Richards's departure, congratulate him warmly on his advancement. They prophesy that he will have a very successful tenure of the chair at Bangor. With large developments pending there, Dr. Richards's organising ability and co-operative nature should be valuable assets.

Engineering at Manchester: Prof. A. H. Gibson

PROF. A. H. GIBSON is to retire from the Beyer chair of engineering in the University of Manchester in September. He will then have occupied this famous chair for twenty-nine years, with a distinction well worthy of the traditions created by his master, Osborne Reynolds. Both at Manchester and in his inspiring re-organisation of the Engineering Department of the University of St. Andrews between 1909 and 1920, Prof. Gibson has maintained a firm belief in Reynolds's conception of the aims and methods of university education in engineering: to teach fundamentals and "the physical laws on which mechanics as a science are based"—and to eschew 'spoon-feeding'. His original work is described in an impressive series of books and papers remarkable for the clarity of his writing, the directness of his arguments and the skill of his experimenting. A very few titles taken at random reflect the range of his interests: "On the Depression of the Filament of Maximum Velocity in a Stream flowing through an Open Channel"; "On the Local Intensification of Draught produced in a Horizontal Air Current by the Presence of an Inclined Rod"; "A Study of the Circular-Arc Bow Girder"; "The Behaviour of Bodies Floating in a Free or a Forced Vortex"; "Piston Temperatures and Heat Flow in High Speed Petrol Engines"; "Tidal Model of the Severn Estuary".

Prof. Gibson was for a time simultaneously a member of the Severn Barrage Committee and of the Air Ministry Engine Research Committee. Since 1926, however, his special interest has been in the use of hydraulic scale-models, and a natural outcome of his great efforts in this field was the establishment in 1946 of the Hydraulics Research Organisation of the Department of Scientific and Industrial Research. At the present time, no fewer than six university chairs are occupied by former students and members of his staff, and his personal influence among students and practising engineers alike is as significant as (to quote the citation of the Ewing Medal awarded to him in 1938) his "specially meritorious contributions to the science of engineering in the field of research".

Prof. W. R. Hawthorne

WILLIAM REDE HAWTHORNE, who is succeeding Prof. A. H. Gibson, was educated at Trinity College, Cambridge. He obtained first-class honours in the Mechanical Sciences Tripos and was awarded the Rex Moir Prize. On leaving Cambridge he joined the firm of Babcock and Wilcox, where for a short time he worked on boiler research. He then obtained a Commonwealth Fund Fellowship, which enabled him to go to the United States and work for two years at the Massachusetts Institute of Technology on combustion research. On the completion of this work he returned to England to his old firm. When the Second World War broke out he joined the research staff of the Air Ministry, being later transferred to the Ministry of Aircraft Production. He worked for a short time at the Aircraft Testing Establishment at Boscombe Down and then moved to the Engine Department of the Royal Aircraft Establishment at Farnborough. At Farnborough he was quickly drawn into the work proceeding there on gas turbines, and in a short time was put in charge of this work. In 1944 Dr. Hawthorne was transferred to the headquarters branch of the work, where he became responsible for directing the work on gas turbine research. At the end of the War he returned to the United States and took up a post as lecturer at the Massachusetts Institute of Technology, where he is at present the Westinghouse professor of gas turbines. Prof. Hawthorne is known for the researches directed by him on gas turbines during the War and for his interest in the combination of fluid flow and combustion usually termed 'gas dynamics'.

Scientific Civil Service: Promotion of Individual Research Workers

IT is announced that additional special posts have been created this year for individual research workers of exceptional quality under provisions included in the White Paper on the Scientific Civil Service (Cmd. 6679, 1945). In recognition of their personal work, promotion to these posts in the grade of senior principal scientific officer (salary scale, £1,320–£1,520) has been awarded to the following officers: C. A. Adams (Ministry of Supply), a mathematical physicist whose researches in ballistics and in ultra high-speed photography have led to results of the highest importance; Dr. H. A. Baylis (British Museum (Natural History)), a systematic zoologist, who has made notable contributions to our knowledge of the parasitic worms, particularly those of importance in medical and veterinary work; Miss F. B. Bradfield (Ministry of Supply), whose numerous contributions in aerodynamics to aeronautical research have been of outstanding scientific and industrial value; H. C. Calpine (Admiralty), a pioneer in radar, who has contributed in a large measure to the successful development of naval fire-control radar, and is now engaged on research into the difficult problems of weapon control; W. G. Campbell (Department of Scientific and Industrial Research), who has made many original contributions to the chemistry of wood, some of considerable technical importance; J. N. Carruthers (Admiralty), whose investigations on tidal currents have earned for him an international reputation, and who has brought together a valuable oceanographical library; J. S. Dick (Ministry of Supply), a physical chemist and a leading authority on pyrotechnics who has a long record of outstanding achievements in this field; J. W. Fisher (Admiralty), who is engaged on theoretical and experimental investigations in hydrodynamics and acoustics with special application to the reduction of ship noise and to the examination of cavitation phenomena; H. L. Green (Ministry of Supply), who has made important contributions to the study of particle suspensions and has developed this branch of physics to a very high degree of precision; J. S. Hey (Army Operational Research Group, War Office), who, in the course of his work on radar and the ionosphere, has carried out important investigations on abnormal radiations from the sun and the galaxy and on echoes due to meteors; Dr. H. London (Ministry of Supply), a physicist whose outstanding work before the War was on the effect of high frequencies on supra-conductivity; more recently, he has worked on the separation of stable isotopes, and has achieved results of considerable practical and theoretical importance in the separation of carbon-thirteen by low-temperature distillation; A. R. Rangabe (Admiralty), who was concerned prior to the War with the development in industry of electronic tubes of all descriptions; his ingenuity and flair for developing manufacturing techniques, and his understanding of the problems and difficulties in manufacture, have particular significance at the present time; Dr. E. Roberts (Ministry of Supply) has a long and successful record of important and fundamental work on diverse aspects of the chemistry and production of explosives.

National Institute of Sciences of India: New Fellows

At the meeting of the National Institute of Sciences of India on January 4, 1949, the following elections were announced. *Honorary Fellows:* Prof. Louis de Broglie, professor of theoretical physics, Poincaré Institute, Sorbonne, Paris; Prof. Hans von Euler, emeritus professor of chemistry, University of Stockholm; Dr. Harlow Shapley, director of Harvard Observatory, Cambridge, Mass.; Prof. Georg Tischler, Botanical Institute, University of Kiel. *Ordinary Fellows:* Dr. J. L. Bhaduri, lecturer in zoology, University of Calcutta; Dr. S. Bhagavantam, scientific liaison officer for India in the United Kingdom; Dr. S. K. Chakrabarty, director, Colaba and Alibag Observatories, Bombay; Dr. D. Chakravarti, lecturer in chemistry, University of Calcutta; Dr. M. Damodaran, assistant director, National Chemical Laboratories, Delhi; Dr. B. K. Das, professor of zoology, Osmania University, Hyderabad-Deccan; Dr. Kurien Jacob, palæobotanist, Geological Survey of India, Calcutta; Dr. T. S. Mahabale, lecturer in botany, Royal Institute of Science, Bombay; Dr. H. K. Mitra, refractories engineer, Tata Iron and Steel Co., Ltd., Jamshedpur; Dr. K. Mitra, officer in charge, Nutrition Scheme, Public Health Laboratories, Patna; Dr. A. H. Pandya, director, Hindusthan Aircraft, Bangalore; Dr. N. Parthasarathy, geneticist, Indian Agricultural Research Institute, New Delhi; Dr. C. Racine, professor of mathematics, Loyola College, Madras; Dr. K. C. Sen, director, Indian Dairy Research Institute, Bangalore; Dr. R. S. Varma, reader in mathematics, University of Lucknow.

Production of Radioactive Isotopes in Britain

The large atomic pile (BEPO) at the Atomic Energy Research Establishment, Harwell, has begun operating for the production of radioactive isotopes. When it is working at full power later this year, it will be able to produce all the artificial radioactive isotopes required in Great Britain by medical, industrial and other research workers. More isotopes will also be available for export, and it is expected that a steadily increasing demand for them will develop overseas. Materials irradiated in the new pile will be twenty times more active than those so far irradiated in the first and smaller pile. The new pile has a rated output of 6,000 kW. and was designed primarily for experimental purposes. The smaller pile, designed to develop about 100 kW. of heat, started up in August 1947 and has been producing radioactive isotopes since September of that year. Present production is about a hundred and fifty specimens a month.

Vegetation-types Map of Tanganyika

The *Geographical Review* has published a reprint of an article from the January 1949 issue entitled "A Vegetation-types Map of Tanganyika", by the late Clement Gillman. This study of the natural vegetation of Tanganyika Territory by a man who had profound knowledge of the country and of its people is one that should be used as a basis for wise planning, and development. The classification is strictly physiognomic and provides an essential basis for further ecological and geographical investigations. The vegetation of the greater part of Tanganyika Territory is a mixture of woodland or bushland with grassland, the distribution being primarily determined by variations of soil and water conditions and the use made of them by man, although, as the author points out, topography and tectonics influence the climate and distribution of vegetation. The main types shown on the coloured map on a scale of 1 : 2,000,000 include forest, woodland, bushland and thicket, grassland, permanent swamp vegetation, desert and semi-desert, and vegetation actively induced by man in native and non-native cultivations. The term "actively induced vegetation" includes the mixed and constantly changing pattern of cultivated crops, pastures and interspersed remnants of the original vegetation and of scattered small areas of secondary growth. Complexes of vegetation occurring in close conjunction are shown on the map symbolically, using the colour of the dominating type for the ground colour with intrazonals or complexes shown by circles or dots in the colour of their type. Sequences of vegetation types caused by regularly repeated physiographic or hydrographic conditions are shown as "catenas"—a word originally applied to soils in East Africa. The map brings out at a glance the small remnants of evergreen forest left on the main watersheds, and the author stresses the urgency of the threat to the country's water resources. The map also rectifies a commonly held exaggerated view of the size of alien plantations and farming settlements, which appear as tiny specks compared with the great extent of native-cultivated land.

Statistical Estimation

The current mathematical theories concerned with the estimation of one or more unknown parameters in a frequency distribution have been the occasion of much controversy, and the absence of a systematic review of this field at a sufficiently elementary level has been a serious obstacle to the student. Two recent articles by Dr. Leon Solomon published in the *Journal of the Institute of Actuaries Students' Society* (**7**, 144 and 213) go a long way towards meeting this need, and form a most welcome addition to the literature. The first article is chiefly concerned with 'point' estimation. The concept of sufficiency is discussed, the minimum-variance theorem is proved, and the method of maximum likelihood is introduced, the proofs of its main properties being given in outline. The second article is concerned with 'interval' estimation, first from the point of view of the theory of confidence intervals and then in terms of fiducial probability, the contrast between these two methods of approach being illustrated by a discussion of the Behrens–Fisher problem. Rigorous proofs of the theorems are not attempted, and the emphasis throughout is laid on the new ideas which are involved. Another welcome feature of the presentation is the inclusion of many worked examples.

Chemical Society's Anniversary Meeting: Chemistry and Atomic Research

THE Chemical Society is holding its anniversary meetings for 1949 in Oxford, during March 28–30, and then in London, during March 31–April 1. The keynote throughout these meetings will be the recent chemical developments in the field of atomic energy and the way in which radioactive elements may be used in chemical and biochemical investigations. A noteworthy feature is that the Ministry of Supply has invited a number of distinguished men of science from Europe and America to participate in the general discussion and interchange of ideas; it is expected that the following will be present: Prof. R. E. Connick, Prof. J. W. Irvine, Dr. G. Wilkinson (United States); Dr. G. Bouissères, Dr. J. Gueron, Dr. B. Goldschmidt, Dr. M. Haissinsky (France); Dr. L. Yasse, Dr. R. H. Betts (Canada); Prof. O. Hahn, Dr. F. Strassman (Germany); Prof. G. Hevesy (Denmark); K. E. Zuimen, H. Hillert, G. Johannson, E. Berne, R. Lidner (Sweden). The Oxford meeting, at Rhodes House, South Parks Road, will be devoted principally to a symposium on "The Chemistry of the Heavy Elements", consisting of four sessions under the chairmanship of Dr. R. Spence (for the first two), Dr. E. Glueckauf and Dr. J. S. Anderson respectively. This symposium has been arranged in conjunction with the Chemistry Division of the Atomic Energy Research Establishment, and the programme will include a visit to Harwell. In addition, there will be two sessions on "Radioactive Tracers", the first session, "Preparation", being under the chairmanship of Dr. J. M. Fletcher, and the second, "Nuclear Aspects", under Dr. W. Wild. March 31 will be devoted to the annual general meeting of the Chemical Society, and this will be held at Burlington House, London, W.1. The Longstaff Medal will be presented to Sir Cyril Hinshelwood, and this will be followed by Sir Ian Heilbron's presidential address: "Concerning Amino-Acids, Peptides and Purines". On April 1, at the Institution of Civil Engineers, Great George Street, London, S.W.1, there will be a discussion on "The Use of Radioactive Tracers in Chemistry". This will be divided into two parts: the first, on "Applications in Inorganic and Physical Chemistry", with Prof. F. A. Paneth in the chair, and the second, on "Applications in Organic Chemistry and Biochemistry", with Prof. G. Hevesy presiding.

Acoustics Measurements on Church Bells

DURING the Second World War, when the Germans occupied Holland, they ordered that church bells should be collected to provide a source of bronze for war prospects. This plan met with great resistance from the Dutch, so that after the liberation, several hundreds of bells of different origin and ages, which had escaped being melted down, were gathered at a number of places. At the end of the War, the Dutch Department for Research in Arts and Measurements took the opportunity to collect complete information on the æsthetic and acoustical properties of these bells, many of which were two or three hundred years old. Part of this work was carried out by E. W. van Heuven, who is to read a paper on this investigation at a meeting of the Acoustics Group of the Physical Society, to be held at the Royal Society of Arts, John Adam Street, London, W.1, on March 18 at 3 p.m.

Announcements

THE Committee for Agricultural Research of the Privy Council has appointed Prof. James Gray, professor of zoology in the University of Cambridge, to be a member of the Agricultural Research Council. This is Prof. Gray's second term of office as a member, his first being during 1942–47.

IT is announced from the University of London that Dr. J. H. Taylor has been appointed to the University chair of geology tenable at King's College as from October 1, 1949. The following doctorates have been conferred: *D.Sc.* on Mr. R. L. Wain (reader at Wye College); *D.Sc.(Eng.)* on Mr. A. R. Collins (Imperial College of Science and Technology).

MR. A. L. FLEET, formerly assistant secretary and registrar of the University of Bristol, has been appointed assistant secretary of the Association of Universities of the British Commonwealth, the office of which is now at 5 Gordon Square, London, W.C.1.

THE Rouse Ball Lecture in the University of Cambridge will be given by Prof. W. Pauli, of Zurich, at noon on March 10. His subject will be "Physical and Mathematical Aspects of Recent Developments in Quantum Electrodynamics". The lecture will be in English and open to all who are interested.

A MEETING at Göttingen of the Deutsche Bunsengesellschaft für physikalische Chemie has been arranged for April 23–24, 1949.

THE Institute of Welding and the British Welding Research Association are arranging a Conference on "Welding as an Aid to the Saving of Steel and Manpower", to be held at Ashorne Hill, near Leamington Spa, during March 22–25. Applications for tickets and all correspondence should be addressed to the Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

UNDER the terms of a grant from the Cotton Industry War Memorial Trust, the Textile Institute is offering to young craftsmen in the cotton spinning and weaving industry a three-year scholarship (of about £750 total value) to study textiles at a university. This scholarship is in addition to the new £1,000 open scholarship of the Institute. Details of both scholarships are available from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3.

THE Institution of Naval Architects is offering the following scholarships to British subjects less than nineteen years of age: Trewent, for naval architecture, £175 a year, tenable at the Universities of Durham, Glasgow, Liverpool, and the Royal Naval College, Greenwich, for 3–4 years. Denny, for marine engineering, £130 a year, tenable for four years at the University of Glasgow. Entries for the above close on May 31. Full particulars may be obtained from the Secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurement of Sperm Activity before Artificial Insemination

THE successful application of artificial insemination largely depends on the possibility of making a quick assessment of sperm activity in the sample of semen to be employed. The existing methods of assessing sperm activity suffer from certain disadvantages. They are either subjective, depending on the judgment of an individual who has often examined semen under the microscope, or they involve chemical treatment which may take some time to complete. The most satisfactory is the fructolytic test, which not only gives a combined measure of sperm motility and density[1], but also provides an indication of the hormonal (testosterone) activity of the bull[2]. On the other hand, samples have to be taken from the ejaculate and incubated at 37° C. for one to three hours.

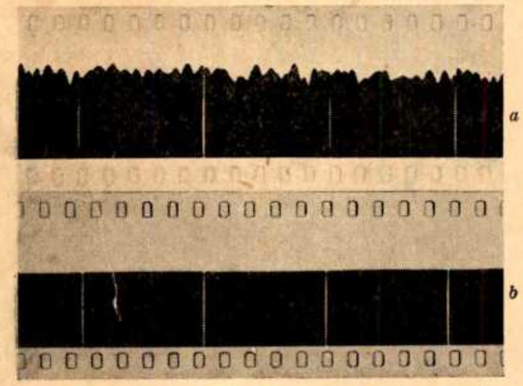

Fig. 1(*a*). Impedance of ram semen containing active spermatozoa. (*b*) Impedance of the same semen after spermatozoa have become motionless. Time-marker, 30 sec.

These difficulties are avoided to a considerable extent by an electrical method of assessing sperm activity. The method is based on the observation[3] that ram semen, when active, exhibits well-defined periodic changes in electrical impedance (Fig. 1). As a result of the experiments on ram semen it was predicted that analogous electrical changes in the semen of other mammals might be too small to observe, or non-existent, unless the density of the sperm were augmented by centrifugation. It has, however, been possible to observe and measure the electrical changes in bull semen with a portable apparatus. Experiments to determine the relative merits of this and other methods of assessing sperm activity have been started; but as these may involve correlating conception-rates with assessments of sperm activity determined in different ways, the results may be considerably delayed.

The apparatus for measuring the electrical changes is mains-operated and consists of a conventional alternating current bridge, energized by a 5-kc. oscillator. The detector is an oscilloscope with amplifier. The method of presenting the data on the oscilloscope is largely a matter of personal choice. For visual observation the electrical changes are usually made to tilt or widen an elliptical trace on the screen. A pair of platinized platinum electrodes (Fig. 2) dip into the semen, in a test-tube or centrifuge tube, preferably in a 'Thermos' flask containing water at 37° C. This forms the unknown arm of the bridge, the voltage across it being about 50 millivolts. Trials are in progress to determine whether this treatment has any influence on the fertilizing capacity of the spermatozoa. At the beginning of an experiment, the resistance and capacity of the unknown arm are approximately balanced. If the semen is fresh and the sperm both active and sufficiently dense, periodic impedance changes, which have the following characteristics, are observed: (1) The frequency is maximal immediately the semen has been collected (Fig. 1*a*). (2) When the sperm are dead or only feebly motile, the frequency is zero (Fig. 1*b*). (3) The frequency is reduced by lowering the temperature, and vice versa. (4) The initial frequency can be maintained by adding phosphate buffer to the semen; this treatment also maintains the fructolytic activity at a high level[1]. (5) The changes can be markedly amplified by increasing the sperm density of the sample.

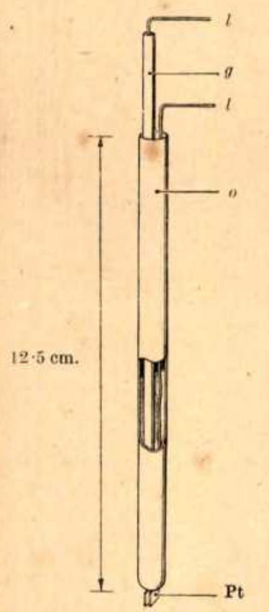

Fig. 2. Electrodes for use with bridge. **Pt**, platinized platinum plates; *l*, leads to bridge; *g*, insulating glass tubing; *o*, outer glass tubing

These impedance changes are unlikely to be caused by alterations in the electrical characteristics of individual spermatozoa, such as take place in a contracting muscle fibre; they are probably due to periodic variations in the positions of sperm in the measuring system. The changes are believed to be connected with the 'turbulent wave formation' that is characteristic of active and dense suspensions of bull or ram spermatozoa (Fig. 3). This wave formation represents a periodic aggregation of spermatozoa, the tails of which probably beat synchronously in the aggregations.

The electrical method of measuring sperm activity has the following advantages: (1) Measurements can be made on the semen while still in the glass receptacle at the end of the artificial vagina, or, if necessary, on a separate $\frac{1}{2}$ c.c. sample. (2) Measurements take about five minutes, after which an 'impedance

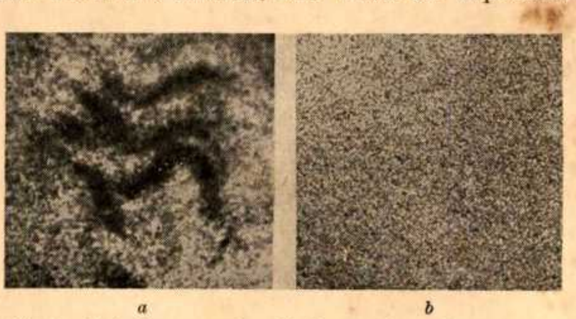
a *b*

Fig. 3. (*a*) Active suspension of bull spermatozoa showing wave formation. Magnification, approx. 40. (*b*) The same suspension of bull spermatozoa after activity has ceased. Magnification, approx. 40

number' (number of spikes/min.) can be assigned to the sample. (3) The method is quantitative and non-subjective. Photographs can be taken for record purposes. (4) The apparatus is portable, and the method of operation can be learnt in a few hours.

The main shortcomings of the method are, first, that it will not provide an assessment of activity unless the semen is sufficiently dense. This may not be serious, as whenever wave formation occurs in semen, impedance changes are observed. Wave formation is usually accepted as a necessary characteristic of semen for use in artificial insemination[4]. Secondly, although the evidence suggests that the frequency of the impedance changes is proportional to sperm activity, further experiments, and, in particular, parallel measurements of fructolysis, impedance numbers and conception-rates, are necessary before the practical value of this method of assessing sperm vitality can be finally established.

A word of warning is perhaps necessary about the assessment of the fertilizing capacity of sperm samples from measurements of sperm activity. Many other factors, apart from the ability to move fast, go to make up the fertilizing capacity of a spermatozoon. If this were not so, intergeneric crosses would be possible. Equally, metabolism and motility are not necessarily related to each other in a simple way. Mann and Lutwak-Mann[5] have shown that, in ram semen, both motility and fructolysis can be inhibited by sodium fluoride without respiration being affected to the same extent, while I have found[6] that the oxygen uptake of sea-urchin spermatozoa can be greatly reduced by carbon monoxide without any corresponding decrease in motility.

This work has been carried out in close co-operation with Dr. T. Mann of the Molteno Institute, Cambridge, Dr. L. E. A. Rowson of the Artificial Insemination Centre, Cambridge, and Dr. A. Walton of the Animal Research Station, Cambridge. Part of the cost of this work was defrayed by a grant (March 11, 1948) from the Agricultural Research Council to the Department of Zoology, Cambridge, for a laboratory assistant.

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Photosynthesis in Leaves at Very Low Carbon Dioxide Concentrations

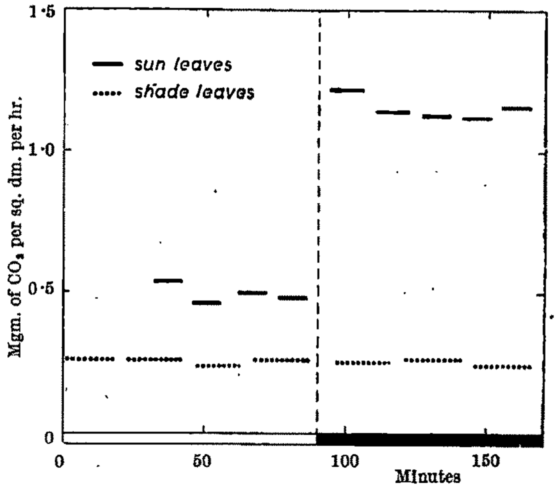
THE photosynthesis of foliage leaves in air free from carbon dioxide is restricted to a re-assimilation of the carbon dioxide which originates from the respiratory process.

Garreau, in the middle of the nineteenth century, demonstrated that green leaves expired carbon dioxide in glass chambers containing small shallow dishes with lime water, or barium hydroxide, when they were exposed to diffuse daylight[1], or even direct sunshine[2,3], that is, the re-assimilation was not complete in surroundings with low carbon dioxide concentrations. F. F. Blackman[4], who, in 1895, placed leaves under similar conditions in a gas stream, could not verify these observations. He concluded that "in bright light a fully green leaf assimilates all the carbon dioxide that it is forming by respiration and none escapes from it". This was the general conception up to 1947.

In this year Audus and Gabrielsen[6], independently of each other, published results which definitely contradicted those of Blackman. Audus performed his experiments in streaming air and exposed the leaves to electric light (intensities up to 3,000 candle-power, or approximately 35,000 lux). He found that the leaves could not re-assimilate more than about nine-tenths of the respiratory carbon dioxide, even at the highest light intensities. Gabrielsen enclosed his leaves in a six-litre flask, illuminated with 10,000 lux, and observed carbon dioxide evolution until a level of about 0·009 vol per cent was reached; these and other static experiments[7] suggest that the photosynthetic process necessitates a concentration of 0·009 vol. per cent carbon dioxide in the surroundings of the assimilation centres before they start working. The rate of carbon dioxide evolution was found to be almost identical for leaves held in light, or in the dark, so long as the carbon dioxide concentration around the illuminated leaves did not exceed 0·006 vol. per cent.

The re-assimilation problem has now been the subject of further studies. Leaves with a total area of 140–170 cm.^{2} were placed in a chamber (150 × 150 × 10 mm.) through which a steady current of carbon dioxide-free air was maintained. The liberated carbon dioxide was absorbed in 0·025 *N* barium hydroxide in a Boysen Jensen tube and measured for periods of 10–20 minutes duration. The temperature of the mesophyll was controlled by means of thermocouples and kept at the same level (± 0·2°) in dark and in illumination experiments.

The results of two typical experimental series (at 20° C. and a flow-rate of 14·8 ml. air/cm.^{2} min. in the leaf chamber) are given in the accompanying graph. Solid lines illustrate results of experiments with sun leaves of *Sambucus nigra* (leaf thickness about 0·23 mm., fresh weight per dm.^{2} 2·51 gm.); dotted lines indicate results of experiments with shade leaves of the same species (leaf thickness 0·13 mm., fresh weight per dm.^{2} 1·34 gm.). The different behaviour of the two kinds of leaves is obvious. In the



Output of carbon dioxide from leaves in light and in the dark. White part of the axis of abscissæ, illumination intensity of 10,000 lux; black part, dark experiments relatively thick sun leaves with a high rate of respiration, 56 per cent of the respiratory carbon dioxide is re-assimilated; in the thin shade leaves, in which the respiration-rate is less than one-fourth of that found for sun leaves, no photosynthesis occurs at all.

Further experiments with *Sambucus nigra* leaves and leaves of other species revealed the following facts: (1) The ratio of the re-assimilation-rate to that of respiration (Q_r) is highest in leaves with high respiration-rates. (2) A comparison of Q_r in thick and thin leaves with identical respiratory-rates shows that the highest values are found in the thick ones. (3) Experiments at different temperatures with one and the same batch of sun leaves show a diminishing of the Q_r values with decreasing rate of respiration. When this latter rate is lowered from 0·58 at 20° ($Q_r = 0{\cdot}41$) to 0·12 mgm. CO_2/dm.^{2} hr. at 5°, no photosynthesis is observed. (4) Re-assimilation begins in shade leaves when the respiration is elevated from 0·31 at 20° to 0·58 mgm. CO_2/dm.^{2} hr. at 30° ($Q_r = 0{\cdot}24$). (5) A variation of the flow-rate of the air in the leaf chamber does not affect the respiratory-rate but shows a marked influence upon the rate of photosynthesis. When the flow-rate is increased from 15·0 to 32·9 ml. air/cm.^{2} min. for sun leaves having a respiratory intensity of 0·62 mgm. CO_2/dm.^{2} hr., the value of Q_r is reduced from 0·50 to 0.

These findings demonstrate that the photosynthesis under the given conditions depends upon: (1) the rate at which carbon dioxide is produced in the leaf; and (2) the rate at which the carbon dioxide is transported from the leaf to its surroundings. If the respiration-rate is low, and/or the possibilities for carbon dioxide to escape are great, no photosynthesis takes place. It is obvious that photosynthesis only occurs when a certain amount of carbon dioxide is accumulated in the green cells. Thus the experiments bring further evidence for the theory of the existence of a threshold value for carbon dioxide concentration in photosynthesis of leaves. The results of the experiments with shade leaves, and the other experiments in which identical rates of carbon dioxide evolution are observed during dark and illumination periods, make it evident that the intermediate products of respiration are not re-utilized in photosynthesis.

A detailed report will appear in *Physiologia Plantarum*.

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Nucleotide Content of the Nucleolus

THE plasmosome type of nucleolus is the only commonly observed intranuclear structure which clearly is not chromatin, from which the nucleolus is easily distinguished by the fact that it gives a negative Feulgen nucleal reaction for desoxypentose nucleic acid. Although it is thus evident that the nucleolus probably does not contain the characteristic polynucleotide of chromosomes, the shape of the ultra-violet absorption curve shows that there is considerable nucleotide of some type in the nucleolus[1]. The basophilia of the nucleolus is attributed to this nucleotide. It can be inferred that at least a part of the nucleolar nucleotide is ribonucleic acid from the fact that ribonuclease reduces the capacity of the nucleolus to bind basic dyes[2]; but this conclusion is open to the objection that the nuclease used was probably contaminated with some protease activity[3].

This communication reports the results of a quantitative study of the effects of chemical extraction[4] and digestion by protease-free ribonuclease[3] on the ultra-violet absorption of the large, homogeneous nucleoli which occur in early meiotic prophase nuclei of sporocytes of *Zea mays*[5]. Each absorption determination was made through a central cylindrical area of a whole nucleolus, in paraffin sections of material fixed in Carnoy's acetic alcohol, using a quartz microscope and suitable photometric apparatus[5]. In each of the three experiments the extraction or digestion caused approximately the same percentage reduction of the extinction (about 53 per cent), which shows that each time the same total mass of absorbing substance was removed from the nucleoli.

Effects of chemical and enzymatic removal of nucleotide from fixed nucleoli of sporocytes of *Zea mays*, measured by ultra-violet absorption

Treatment	Number of nucleoli	Mean E_{2537}	Reduction of extinction	Percentage reduction
		Experiment No. 1		
None	23	0·874±0·010		
Hot TrAc	10	0·407±0·009	0·467	53·4
		Experiment No. 2		
None	17	0·843±0·016		
Ribonuclease	17	0·395±0·010	0·448	52·8
		Experiment No. 3		
None	31	1·000±0·014*		
Cold TrAc	31	0·860±0·011	0·140	14·0
Hot TrAc	30	0·472±0·008	0·528	52·8

Abbreviations: E_{2537}, extinction at wave-length 2537 A.; TrAc, 5 per cent trichloracetic acid. * The higher extinction values of Experiment 3 are due to the fact that absorption was measured through a narrower central area of the nucleolus, with a correspondingly longer optical path

All nucleotides are soluble in hot 5 per cent trichloracetic acid[3], and therefore the amount of reduction of extinction caused by this treatment, Experiment 1 (0·467), is a measure of the *total nucleotide content of the nucleolus*. The residual light loss, or blank (0·407), is presumably due to specific protein absorption and to non-specific light reflexion and scattering[1,5]. All this nucleotide absorption is removable by ribonuclease digestion, Experiment 2, which shows that the *nucleolus contains only nucleotide of the ribose, or pentose, type*. Slightly more than one-fourth of the nucleotide is soluble in cold 5 per cent trichloracetic acid, indicating that this proportion is a *lower nucleotide polymer than nucleic acid*[3]. There is evidence that fixation in Carnoy's fluid[3] removes from cells practically all the common acid-soluble mononucleotides[6], which suggests that the cold acid-soluble nucleolar nucleotide which survives Carnoy fixation may be a polymer which is intermediate between mononucleotide and nucleic acid. One of the interesting possibilities raised by the presence of this smaller ribose polynucleotide is that the nucleolus may be a site of synthesis of ribonucleic acid.

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Orientation of the Mitochondria during Mitosis

LITTLE is known concerning the behaviour of the mitochondria during cell division. Therefore we have studied the mitosis of cells from the tail of the pancreas in very young albino mice of the Danish State Serum Institute strain. The mice were three to eight days old (weight, 3–3½ gm.). For vital staining of the pancreatic cells the technique of Scott[1] was used. The carotids were clamped, a needle, wire gauge 26–27 (outer diameter, 0·5 mm.; inner diameter, 0·22 mm.), was introduced into the left ventricle of the heart, and Janus Green B solution 1/100,000 was injected at a pressure of 250–300 mm. mercury in the course of some fifteen minutes. The heart was contracting during the injection.

Half an hour before this procedure, 0·1 c.c. heparin solution (5 : 100) had been injected into the abdominal cavity.

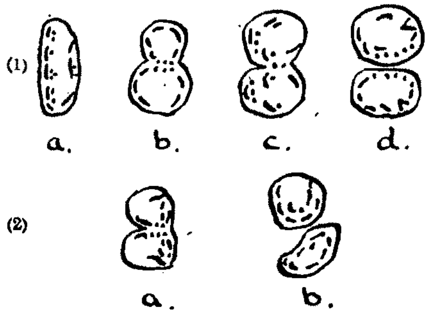
In 190 mice thus examined, only 51 mitoses were seen going on, including all phases of the division.

As soon as the injection has been finished, the pancreas was dissected out; this takes about five minutes, and a bit of the tail was pressed between a slide and a coverslip. The cells were observed at a magnification of 2,400 × (Zeiss, apochrom. *H I* 90, *K* 7 ×, binoc.) During the observation the preparation was kept at 20–22° C.

We tried to photograph the mitochondria, but did not obtain satisfactory pictures, possibly because proper film material was not at our disposal.

During all the phases of mitosis the mitochondria always move in such a manner that they are symmetrically arranged in relation to the plane of cleavage. This is seen from the drawings.

This finding is in accordance with the statistical observations reported by M. D. Thurlow[2,3], from whose work it seems probable that in mice all nerve cells contain the same number of mitochondria.



Mitochondria during mitosis: (1) Mitosis from prophase to telophase; (2) mitosis from anaphase to telophase

The symmetrical distribution of the mitochondria during mitosis indicates that they are of high importance to mitosis, and in their behaviour cannot but remind us of chromosomes during division.

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Feeding and Reproduction in the Pyramidellids

THE mode of life and relationships of the Pyramidellidæ have remained more obscure than those of any other group of the gastropods, though such aberrations as the presence of a radula, the hermaphrodite gonad and their suspected parasitic habit have aroused comment[1,2]. Pelseneer[1] described the feeding of *Brachystomia rissoides* (Hanley) = *Odostomia scalaris* Macg., which is parasitic on *Mytilus*: several individuals congregate on the edge of the shell of the mussel and each protrudes a long proboscis which is fixed to the inner surface of the mantle. No further details are given.

A similar association has now been established between five other species of pyramidellids and other animals, and the feeding process observed. *Odostomia eulimoides* Hanley lives on scallops, *Pecten* and *Chlamys*; *O. lukisii* Jeff., *O. plicata* Mont. and *O. unidentata* Mont. lurk among colonies of *Pomatoceros*, *Serpula* and *Spirorbis*; *Chrysallida spiralis* Mont. on those of *Sabellaria* spp., while it is known that *Turbonilla rufescens* Forbes is associated with a cœlenterate as yet unidentified. When the opportunity occurs, these molluscs extend a long proboscis and attach it to the body of their host—to the mantle of a lamellibranch, the tentacle of *Pomatoceros*, or, in the case of *C. spiralis*, it is thrust through the mouth of *Sabellaria* and fastened to the wall of the gut.

The gut is extremely specialized in connexion with this mode of feeding. There is a long introvert lined by a specialized epithelium, and when this is protruded it is found that the mouth is surrounded by a sucker by means of which the proboscis is fastened to the body of the host. Above the mouth, in the centre of the sucker, lies a second opening from which projects a long, hollow stylet which represents the fused jaws. Both mouth and stylet lead to a long, narrow tube, the modified buccal cavity, divided into two channels: the ventral, from the mouth, leads to a muscular pump; the dorsal contains the stylet into which run the ducts from the salivary glands. The sucker secures the proboscis to the prey; the body is pierced by the stylet, saliva may be used to loosen the tissue, and fluid, with perhaps loosened cells, is then sucked in through the mouth by the pump. The œsophagus is a long capillary tube leading to a simple stomach, and a short rectum passes to a mantle cavity, which contains many simplifications similar to those described in *Omalogyra*[4].

Each species of pyramidellid seems to restrict its feeding to one host. Were we to know these, then it appears that the collection and study of this little-known group would be greatly simplified.

Specialization also extends to the reproductive system, and of particular interest is the method of copulation, for this appears to be effected by an invaginable tube which passes *through* the nerve ring ventral to the gut. The tube, together with its accompanying muscular pouch, is reminiscent of the copulatory apparatus of *Omalogyra*[4], which, however, is contained within the hermaphrodite duct and is not an independent structure. The eggs of *Odostomia* spp. are laid on their feeding grounds—on the shells of lamellibranchs or among the tubes of polychætes. A number of eggs are embedded in a copious supply of jelly[3] which binds them together and to the substratum, and which is produced by the hypertrophy of the upper part of the pallial oviduct during the female phase of these protandrous hermaphrodites.

The structure of the nervous system, gut and reproductive system may be shown to be consistent with the classification of the Pyramidellidæ as prosobranchs rather than opisthobranchs.

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Oct. 29.

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Cotton Crop Yield in Relation to Application of Fertilizers

IT is unfortunate that efforts to study the effect of various fertilizers on the cotton yield in Egypt have led to contradictory results. Thus Hughes[1], Prescott[2], and Khalil and co-workers[3] have reported that manuring has very little or no effect on the yield of cotton crop, while Mahmoud and Crowther[4,5,6], have shown that cotton produces better yield in response to nitrogen and phosphate applications, potash addition being without effect.

Several investigators[7,8,9] have found a correlation between the mineral composition of plant leaves, crop yield and fertilizer applications. We have carried out an experiment in which we have used foliar analysis of cotton (variety Menoufy) as an index to the nutrient conditions and crop yield of the plants. The soil plots that have been used in the present investigation are loamy in texture, situated in the farm of the Faculty of Agriculture, Fouad I University, at Giza, and have been under five controlled treatments since 1932. Each plot has seven replicates (9·20 × 8·20 m.) distributed according to the Latin square method.

The results seem to indicate that addition of any fertilizer gave better yield than that of plants grown in the completely unfertilized plots. It must be remembered, however, that the soil of the untreated plots has been without any fertilizer application since 1932; naturally such soil is rather spent. The plants that have been grown in plots supplied with full manure of phosphorus, potassium and nitrogen gave a higher yield than that obtained from plants given phosphorus and potassium but no nitrogen fertilizer. Non-addition of potassium or phosphorus fertilizer seems to have very little effect on the crop yield. The results have also shown that the Egyptian soil contains relatively large amounts of unavailable phosphorus and potassium, but little nitrogen; hence the need for addition of nitrogen fertilizer alone. We believe that the most suitable nitrogen fertilizer would be ammonium sulphate, because the ammonium–nitrogen will soon be transformed into nitrate by means of nitrifying and nitrating bacteria which are usually abundant in Egyptian soil fit for cultivation. In the meantime the sulphate ion will help to neutralize the alkalinity of the soil (the *p*H of the soil being usually about 8·0), and in doing so it renders available some of the naturally occurring unavailable phosphorus.

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Faculty of Agriculture,
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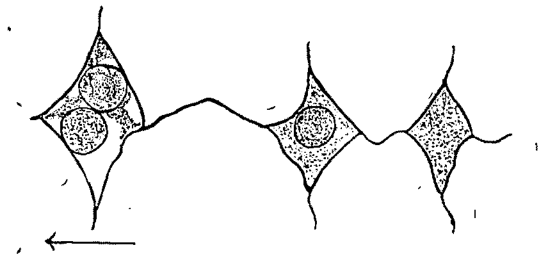
Intercellular Inclusions in White Mustard Roots Induced by Colchicine Treatment

DURING the course of an anatomical study of colchicine-induced hypertrophy in white mustard roots, attention has been given to some peculiar intercellular inclusions which are certainly not present in untreated roots. In this study, newly germinated seedlings are immersed in a 0·1 per cent colchicine solution for two hours, thoroughly washed in distilled water and then placed on moist filter paper to grow for a period of three days. At the end of this time, marked hypertrophy, characterized by stunted swollen root tips and an exceedingly dense development of root hairs, is obvious.

As already noted[1], rows of radially placed intercellular spaces occur at an early stage in the meristem of normal white mustard roots and are thought[2] to facilitate the more rapid movement of food materials to the surface cells. In hypertrophied root tips they are also conspicuous, but here they frequently contain a granular substance and spherical bodies which are comparable in size, stain reaction and general appearance to nuclei in adjacent cortical cells. Since the walls of the cortical cells forming the spaces are intact, the inclusions might be considered to be of the nature of tyloses or internal 'root hairs' growing from the cortical cells. Such an idea would fit in with the irregular swelling of the epidermal cells, marked increase in cellular volume of the cortex and the abnormal production of root hairs by the root



Drawing × 1,300, in cross-sectional view, of one row of radially arranged intercellular spaces in the cortex of a hypertrophied root, showing the intercellular inclusions. The arrow points to the outside of the root cap cells. If the inclusions are tyloses they should be surrounded by cell walls of their own. The presence of a cell wall is still under investigation; but, as soon as this has been decided, further data, including other abnormal features in these roots, will be published.

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Liberation of *nor*Adrenaline from Adrenal Medulla by Splanchnic Stimulation

The active principle of the suprarenal medulla is commonly believed to be adrenaline. Holton[1] has recently shown, in this laboratory, that tumours of the medulla contain the non-methylated primary amine *nor*adrenaline in greater amount than adrenaline.

We have examined extracts of the suprarenal glands of dogs by determining the power of the extract to inhibit (*a*) the isolated rabbit intestine, and (*b*) the isolated rat uterus when stimulated by acetylcholine. The former test measures adrenaline plus *nor*adrenaline, the latter measures adrenaline only. We found that of five glands, two contained adrenaline only, while the active material in the other three was a mixture containing 14, 28 and 52 per cent *nor*adrenaline.

To find if *nor*adrenaline is actually liberated when the splanchnic nerve is stimulated, we have examined the effect of stimulating the splanchnic nerve in the cat. The experiments were carried out in spinal cats from which the viscera were removed and the kidneys excluded from the circulation. In these circumstances, splanchnic stimulation sent impulses to the suprarenal medulla only.

To distinguish between adrenaline and *nor*adrenaline, we used, in each experiment, the nictitating membranes of the same cat, one of which had been denervated not less than eight days previously by extirpation of the superior cervical ganglion. When an injection of adrenaline was made, the denervated membrane usually contracted more than the normal membrane, the mean value for the ratio of the size of the contractions being 1·6. When an injection of *nor*adrenaline was made, the ratio was, however, much greater, the mean value being 9·1. The ratios remained very nearly the same in any one experiment. When the splanchnic nerve was stimulated, the nictitating membranes contracted, and the ratio of the contractions indicated that the stimulation liberated a mixture of adrenaline and *nor*adrenaline. We were able to match the effect of splanchnic stimulation by the intravenous infusion of an equipressor mixture of adrenaline and *nor*adrenaline, and found that in different experiments the proportion of *nor*adrenaline varied from 20 (or less) to 80 per cent of the total active material secreted.

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Central and Peripheral Mechanisms in the Increase of Metabolic Rate; Mode of Action of Thyroxine

It is sometimes difficult to decide whether an increase in metabolism is due to stimulation of the hypothalamic centres or to direct action on tissue respiration. Neither transection of the cervical spinal cord nor administration of barbiturates furnishes convincing evidence[1,2]. The former does not interfere with the nerve supply of the muscles of the head and the neck, nor with the connexions of the abdominal organs with the central nervous system through the vagi. Barbiturates may directly depress tissue respiration.

Morphine-scopolamine narcosis gives a more definite answer. This combination acts preferentially upon the hypothalamic centres without influencing tissue respiration. It does not decrease the basal metabolic rate of rabbits, nor does it affect the increase in the metabolic rate brought about by adrenaline or 2,4-dinitrophenol, the action of which is known to be peripheral[3,4]. On the other hand, it restores to normal values metabolic rates which have been increased by some central mechanism, as in the case of cooling the animal or administration of β-phenyl*iso*propylamine ('Benzedrine', 'Amphetamine').

If thyroxine is used to increase by 50 per cent the metabolic rate of rabbits, morphine-scopolamine has a depressing effect, although the rate cannot be restored to the normal value. Thus we conclude that, in the thyroxine effect on rabbits, a central as well as a peripheral mechanism is involved.

In birds, red blood-cells can be used for distinguishing between central and peripheral action upon metabolism. If the metabolism of ducks is raised by means of some action depending upon a central mechanism, such as cooling or subcutaneous administration of β-phenyl*iso*propylamine, there is no change in the oxygen consumption of these cells, which have no connexion with the nervous system, as measured on a suspension in the Warburg apparatus. On the other hand, adrenaline or dinitrophenol, administered subcutaneously, increases the *in vitro* respiration of the red cells. If we add blood plasma of an animal thus treated to a normal suspension of red cells, an increase in oxygen consumption of these cells ensues.

It has been found that after administration of thyroxine for four days, the respiration of the blood cells has increased to the same extent as the metabolic rate of the whole animal. Both effects fall off together. Blood plasma of a thyroxine-treated animal is unable to raise the oxygen consumption of a normal red blood-cell suspension. This may be explained by assuming that it takes some time for the thyroxine molecule to be built into the enzyme system of the cell. It is concluded that the metabolism-stimulating action of thyroxine in birds is entirely peripheral.

Detailed accounts of these investigations will appear elsewhere.

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Tubular Factors in the Development of Extra-renal Azotæmia

It is well known that in the mechanism of extrarenal azotæmia the causative factor is the loss of sodium and subsequent dehydration[1]. According to Gömöri and co-workers[2], the causes of dehydration-azotæmia are as follows: (1) blood pressure falls, and in consequence of the dehydration the colloid-oncotic pressure of the blood plasma increases, thus resulting in a drop of the glomerular filtration-rate; (2) circulation is slowing down, contributing thus to the diminished filtration-rate; (3) excessive rotein catabolism helps to aggravate the uræmic condition.

Some clinical observations, and the fact that during dehydration the concentrating power of the kidneys decreases, led us to investigate the role of the tubules during this condition.

Dehydration was developed in rabbits, by Darrow and Yannet's technique[3], of infusion to, and subsequent withdrawal of, an isotonic dextrose solution from the peritoneal cavity. Our results show clearly that: (1) in dehydration there is a significant decrease of the endogenous creatinin clearance (glomerular filtration-rate), but a still greater decrease of the urea clearance; in the control period, the ratio urea clearance/creatinin clearance was 0·68–0·87, whereas during dehydration it was 0·07–0·20; (2) this must be due to enhanced tubular re-absorption of urea; normally 20–40 per cent of the filtered urea was re-absorbed, but during dehydration it was as much as 80–90 per cent.

Thus it seems to be beyond doubt that in the development of dehydration-azotæmia, besides the hæmodynamic glomerular factors, a tubular factor plays its part too. The cause of the increased re-absorption of urea may be found in various factors. The known diffusibility of urea renders it especially liable to passive re diffusion. But it seems to be certain that the histological changes in the kidneys of dehydrated animals (Gömöri and Romhányi's[4] findings of medullary hyperæmia and tubular lesions in dehydration) make the tubules especially suited for re-diffusion. These histological changes were found in our experiments also.

Period	Interval (min.)	Urine flow (ml./min.)	Creatinin		Urea clear.	Urea clear. / Creatinin clear.	Serum NPN (mgm. %)
			U/P	Clear.			
1	225	0·178	73	13·0	8·8	0·68*	26
2	524	0·136	33	4·5	1·8	0·40	40
3	1429	0·031	96	3·0	0·30	0·10	64
4	1964	0·045	16	0·7	0·07	0·10	90
5	2934	0·007	17	0·12	0·008	0·07	110
6	3390	0·091	12	1·1	0·22	0·20†	144
7	4319	0·131	19	2·5	0·45	0·18	164

* Before treatment. † Partial re-hydration with water.

In the table we give the results of one of our typical experiments. The ratio of urea to creatinin, expressing the tubular water re-absorption, emphasizes that the tubular re-absorption of urea is independent of the changes in water re-absorption, as well as being independent of the rate of urine flow.

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Effects of a Serum Injection after an Anti Histaminic-Inhibited Shock

Pasteur, Vallery Radot, Halpen and Haltzer assert that an anti-histaminic-inhibited shock has n tachiphylactic action; more precisely, rabbits pro tected from a shock by an anti-hystaminic died o shock after another dose of serum was administere some days later. They considered the results as a argument in favour of their theory, namely, that anti histaminics prevent antigen-antibody reactions an thus leave the tissues free from antibodies to react with a subsequent dose of antigen. We have obtaine contrary results, however, in analogous experiments Thirteen guinea pigs have been sensitized wit 1/10 c.c. of horse serum by intraperitoneal injection. After fifteen days they were given 1 c.c. of the sam serum by intracardiac injection. Eleven were give 5 mgm. of an anti-histaminic ('Dimetina', kindly furnished by Le Petit Co.) by intraperitoneal injection 10 min. before the shock treatment. All o them survived, whereas the other two died.

These eleven guinea pigs were given next day another shock treatment with 1 c.c. of the same serum treatment by intracardiac injection. All of them survived. The weight of each guinea pig was about 300 gm.

Thus it seems that the anti-hystaminics do not inhibit the antigen-antibody reaction, and the latter disappears after an anti-histaminic-inhibited shock. This fact may be of considerable therapeutical value.

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Folic Acid as an Anti-anaphylactic

Ten guinea pigs (of medium weight, 350 gm.) were sensitized with 1/10 c.c. of horse serum by intraperitoneal injection. After fifteen days, two of them, used as controls, were given 1 c.c. of the same sensitizing serum directly into the heart; both died. Another guinea pig was given, intramuscularly, 15 mgm. of folic acid ten minutes before receiving the same dose of serum by intracardiac injection. This guinea pig also died of anaphylactic shock. Six others were given 30 mgm. of folic acid by intraperitoneal injection (to accelerate absorption), and the same serum treatment fifteen minutes later. All of them survived. Finally, the last guinea pig was given 15 mgm. of folic acid intraperitoneally and the same serum treatment after fifteen minutes. This one survived, too, but showed slight symptoms of shock.

These experiments show clearly a protective action of folic acid against the anaphylactic shock in guinea pigs. This action reveals itself after a certain time and using very large doses of folic acid. Thus it may be supposed that folic acid acts in macrocytic anæmia as an anti-anaphylactic and thus antihistaminic. Assuming, as a pure hypothesis, that macrocytic anæmia may be due to an anaphylactic blockage of bone-marrow, especially as regards erythropoiesis, the successful results obtained with small doses of folic acid might be explained by a particular anti-anaphylactic action of this substance specific for normal erythropoiesis cells.

It may be remembered that agranulocytosis of Werner – Schultz, almost universally considered as a "condition caused by an anaphylactic crisis of bone-marrow" (Bock[1]), has been cured with massive doses of folic acid by Gendel, Black and Stanbury[2]. The more spectacular results obtained in the treatment of macrocytic anæmia can be explained supposing that folic acid has much more specific action on the allergic blockage of erythropoietic tissue than on the allergic blockage of the leukopoietic one.

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Presence of Histamine in Central Nervous System Extracts

It is well known that alcoholic or aqueous extracts of central nervous tissues (especially brain) lower the arterial blood pressure when injected intravenously into laboratory animals (dogs, cats, rabbits, etc.)[1,2,3]. The chemical agent, or agents, of the pressor effect, however, have not yet been identified; studies by Vincent *et al.*[3], Major and Weber[1] and more recently Kwiatkowski[4] having apparently discarded (or greatly minimized) the role of both histamine and choline in the pharmacological activity of the extracts. The object of this note is to present evidence that histamine is the main agent responsible for the depressor effect, and that central nervous system tissues, therefore, as well as many other tissues (liver, lung, skin, muscle, etc.)[5], contain histamine.

	Histamine equivalent of the extracts (µgm./ml.)	gm. tissue / ml. extract	µgm. histamine / gm. tissue	Inhibition of the depressor responses by: benadryl (1 mgm./kgm.)	
					atropine (0·1 mgm./kgm.)
Extract *A* (0·09 ml.)	45	2·6	17·3	26 per cent	0 per cent
Extract *B* (0·125 ml.)	32	2·0	16·0	25 ,,	0 ,,
Equivalent histamine, 4 µgm.	—	—	—	24 ,, (3 mgm./kgm.)	—
Extract B_1 (0·23 ml.)	43	4·4	9·8	67 per cent	—
Equivalent histamine, 10 µgm.	—	—	—	71 ,,	—

To detect histamine in the extracts, we have used (as recently suggested by Loew *et al.*[6]) the new anti-histamine drug benadryl, which in the dog inhibits almost specifically the action of histamine on the arterial blood pressure, approaching the degree of specificity displayed by atropine against acetylcholine. Therefore we tested in *dogs* the action of both benadryl and atropine on the effect of the extracts, and found that benadryl reduced in the same degree the depressor responses both to the extracts and to small doses of histamine, whereas atropine (in agreement with the results of earlier workers[1,3]) left unmodified the depressor response to the former.

The accompanying table summarizes the results of a typical experiment, the extracts having been prepared from ox, sheep, dog or rabbit brain, as follows. The fresh nervous tissue was minced, mixed with twice its volume of 96 per cent ethanol and left (with frequent stirring) either at 20° or in the cold for 4–20 hours. The suspension was then pressed through a thin cloth, and the brain matter extracted once more in the same way. First and second filtrates were collected and evaporated *in vacuo* below 50°; the residue was spun off and the bulky precipitate of denatured proteins and lipids discarded (supernatant: extract *A*). Extract *B* (from ex. *A*) and extract B_1 are the same as extract *A* but treated with basic lead acetate until no more precipitate was formed, centrifuged to eliminate the precipitate, and the lead from the supernatant removed by precipitation with sulphate and centrifugation. After neutralization, the activity of the extracts was tested by injection into the femoral vein of dogs anæsthetized with pentobarbitone, blood-pressure records being taken from the carotid artery. The histamine equivalent of the extracts was determined by comparing the effect on the arterial blood pressure of different concentrations of extract with similarly different concentrations of histamine solutions.

Similar results are obtained with acetone or trichloroacetic[7] extracts of brain. Extractions of the nervous tissues with ethyl ether did not yield active preparations. The extracts, after purification with basic lead acetate, which does not remove the depressor activity (contrary to the findings of Major and Weber[1]) were further fractionated by following the main lines of the procedure described by Best *et al.*[8]. The activity was carried down in both precipitations with phosphotungstic acid and silver-barium hydroxide, the depressor effect of the active fractions, as well as that of the original extract, being inhibited by benadryl.

Full details of this work will be published elsewhere. We are indebted to Dr. J. J. Izquierdo for measuring the potency of some of our extracts.

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Isolation from Acid-Fast Bacteria of a Growth-Factor for *Mycobacterium johnei* and of a Precursor of Phthiocol

Mycobacterium johnei will not grow on plain egg medium; but Twort and Ingraham[1] demonstrated that good growth could be ensured by the addition of acid-fast bacteria or products extracted from them with organic solvents. Egg medium containing 1 per cent dried *Myco. johnei* has been used for many years to cultivate the organism.

We have now isolated from *Myco. phlei* a compound capable of promoting vigorous growth of

Myco. johnei on egg medium. This new growth-factor has been obtained crystalline in the form of a colourless aluminium derivative, melting point 218° (found: C, 63·45; H, 7·9; Al, 3·0 per cent; figures for nitrogen were inaccurate owing to formation of aluminium nitride during combustion). The corresponding metal-free product has been isolated only as an amorphous powder of melting point 170° (found: C, 65·1; H, 8·55; N, 9·0 per cent; optical rotation, $(\alpha)_D^{23}$ $-16°$, $C = 3{\cdot}2$, chloroform). The absorption spectra in methanol show the following characteristics. Metal-free material: max. 250 and 310 mμ, $E^{1\,\%}_{1\,\text{cm}}$ 158 and 42. Aluminium derivative: max. 263 and 342 mμ, $E^{1\,\%}_{1\,\text{cm.}}$ 204 and 58. From the evidence available at present, we believe the approximate formula of the aluminium derivative of the factor to be $C_{49}H_{75}O_{10}N_6Al$.

Woolley and McCarter[2] reported that vitamin K concentrates, phthiocol (2-methyl, 3-hydroxy, 1-4 naphthoquinone) and other naphthoquinone derivatives promoted the growth of *Myco. johnei* on liquid medium, though these anti-hæmorrhagic compounds were less effective than cells of *Myco. phlei*, which they believed to supply some other factor also required for optimal growth.

We believe our growth-factor to be quite unrelated to the naphthoquinones, and using solid egg medium we have been unable to confirm the growth-promoting effect of phthiocol reported by Woolley and McCarter. Moreover, we have now isolated from *Myco. tuberculosis* a product resembling the known K vitamins, and have found that it also fails to promote the growth of *Myco. johnei*.

This compound has been isolated as a yellow oil which appears to be chromatographically homogeneous, but has yielded no crystalline derivative (found: C, 85·1, 85·15, 85·05; H, 10·1, 10·45, 10·25 per cent; molecular weight, cryoscopically in benzene, 688, 706, 691; refractive index $n_D^{25} = 1{\cdot}5286$; hydrogenation (Adams's catalyst) 316 c.c. hydrogen at N.T.P. absorbed per gm. The absorption spectrum in hexane is identical in shape and in the relative heights of the peaks with the spectra of vitamins K_1 and K_2, though the absolute height of the peaks is lower than either.

Quinone from *Myco. tuberculosis*		Vitamin K_2[3]	
max. (mμ)	$E^{1\,\%}_{1\,\text{cm.}}$	max. (mμ)	$E^{1\,\%}_{1\,\text{cm.}}$
242·5	227	243	287
248	241	249	305
260·5	220	260	275
269	216	270	275
325	41	325	53

The absorption coefficient is in agreement with the finding that this compound has a molecular weight greater than that of vitamin K_2 ($C_{41}H_{56}O_2$, mol. wt. 580), presumably due to the presence of a longer side-chain.

This oil yields phthiocol on alkaline hydrolysis, and appears to be the source of the phthiocol which was isolated from extracts of *Myco. tuberculosis* by Anderson and Newman[4]. The possibility that phthiocol might arise from vitamin K was first suggested by Fieser *et al.*[5]. We have failed to detect any free phthiocol in fresh extracts of *Myco. tuberculosis*, and a similar finding has been reported by Parschin[6]. Extracts which have been allowed to stand for some weeks are found to contain phthiocol, and this probably explains the observation of Crowder *et al.*[7], who reported the presence of both free and combined phthiocol in an unhydrolysed extract of *Myco. tuberculosis*.

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Absolute Cross-sections for the Capture of Neutrons of 200 and 900 keV. Energy

KNOWLEDGE concerning compound nuclei can be derived mainly from two groups of experiments. The study of individual levels yields information as to the values that the total and partial widths can assume. Where in one nucleus several neighbouring levels can be observed separately, individual level distances can be determined. A great number of measurements of this second type have been made. They show that level-widths and -distances vary over a considerable range.

The distance between levels, however, becomes so small with increasing excitation energy that it would seem hopeless to derive all information only from observations of separated levels. But the observation of average values of widths and distances—particularly if known as a function of the excitation energy—can in this case be considered as a description of the compound nucleus as a whole.

Bethe and Placzek[1] have shown that the average cross-section for the capture of neutrons with zero angular momentum taken over many levels is

$$\bar{\sigma} = \frac{\lambda^2}{2\pi} \cdot \overline{\left(\frac{\Gamma_n}{D} \cdot \frac{\Gamma_r}{\Gamma_n + \Gamma_r}\right)},$$

where λ is the de Broglie wave-length of the neutron; Γ_r the radiation width; Γ_n the neutron width and D the level-distance. Γ_n/D is the sticking probability. For low neutron energies ($<$ 500,000 eV.) $\Gamma_n < \Gamma_r$, and therefore

$$\overline{\sigma_{\text{cap}}} = \frac{\lambda^2}{2\pi} \frac{\overline{\Gamma_n}}{D}.$$

Above 1 MeV., $\Gamma_r/(\Gamma_n + \Gamma_r)$ decreases rapidly with energy.

A number of theoretical attempts have been made to determine the value of $\frac{\Gamma_n}{D} \cdot \frac{\Gamma_r}{\Gamma_n + \Gamma_r}$. Qualitative considerations of Bohr's theory of the compound nucleus predict a continuous increase with increasing mass number. The quantitative theories of Bethe, Peierls and Kapur[2], and more recently Feshbach, Peaslee and Weisskopf[3], again show a monotonic increase of σ with mass number.

Determinations of $\overline{\sigma_{\text{cap}}}$ should be made with neutron sources with a spread in energy distributions which is small compared to the mean energy but big compared to $\overline{D}$, the mean level-distance, so that the experimental result is a mean over many levels. (This is, for example, the case for the photo-neutrons produced by radiothorium in heavy hydrogen ($E = 200 \pm 28$ keV.) and beryllium ($E = 900 \pm 13$ keV.), and also for D—D sources, with certain precautions as to target thickness and angular distribution.)

Measurements of this kind have already been made[4]. They all show that $\overline{\sigma_{\text{cap}}}$ does not vary monotonically with the mass of the compound nucleus formed by the capture of the neutrons. In these circumstances, it seemed desirable to repeat the measurements with all possible precautions, avoiding slowing down of neutrons in the source and by the surroundings and also taking into account new data obtained for the absorption coefficients of β-rays.

The capture cross-sections of the elements for 900-keV. neutrons were measured in the following way. The cross-section for manganese was determined absolutely by irradiating a manganese sulphate solution with a radiothorium–beryllium photo-source, under conditions in which it is possible to calculate the fraction of all neutrons captured by the manganese. The radioactive manganese is precipitated from part of the solution and its β-activity measured on a Geiger–Müller counter. The same precipitated powder is then irradiated by the photo-source in air, and its β-activity again measured. The absolute cross-section of neutron capture can be calculated directly from the ratio of the two counts and the ratio of capture cross-section of manganese to hydrogen for thermal neutrons; it is not necessary to know the absolute neutron flux or the β-counting efficiency of the Geiger–Müller counter.

The cross-sections for the other elements were then determined by measuring the ratio of their β-activities to that of the manganese when irradiated by the photo-source in air, and also the ratio of the self-absorption of their β-rays to the β-rays of manganese. The cross-sections for 200-keV. neutrons were obtained directly by using these results in conjunction with those of Allen and others[5], who found the ratio of the cross-sections for 900 and 200-keV. neutrons. The results are given in the accompanying table.

Isotopic cross-sections (millibarns)

	$^{28}Al_{13}$	$^{56}Mn_{25}$	$^{64}Cu_{29}$	$^{76}As_{33}$	$^{107,109}Pd_{46}$
σ 900	2·05 ± 0·7	7·2 ± 0·7	8·8 ± 1·8	81 ± 7	214 ± 60
σ 200	3·5 ± 1·4	15·6 ± 4	11·4 ± 3	300 + 40	430 ± 140

	$^{111}Pd_{46}$	$^{108}Ag_{47}$	$^{116}In_{49}$	$^{122}Sb_{51}$	$^{128}I_{53}$
σ 900	131 ± 50	370 ± 70	650 ± 110	156 ± 80	180 ± 30
σ 200	146 ± 70	740 ± 160	525 ± 120 54 min.	185 ± 50	300 ± 60

	$^{139}Ba_{56}$	$^{131}Te_{52}$	$^{187}W_{74}$	$^{199}Pt_{78}$	$^{198}Au_{79}$
σ 900	4·3 ± 2	26·5 ± 8	42 ± 7	480±230	490 ± 80
σ 200	8·1 ± 4·3	34 ± 17	60·5 ± 19	1170±600	490 ± 120

Clearly the cross-sections of nuclei of comparable mass number show considerable differences. This is most striking for antimony, tellurium, iodine and barium. Very low cross-sections for bismuth and lead[2] have been found by other authors. It is also obvious that the general tendency of the cross-sections to increase with increasing mass number is not very marked.

It was pointed out by Halban and Kowarski[4] that these selectivities might be due to the strong dependence of $\overline{\sigma_{\text{cap}}}$ on the binding energy, which is known to vary between 6·5 and 10 MeV. in the case of the formation of active nuclei. It is, of course, true that the comparisons of different nuclei would be of more significance if they could be made for constant excitation energy (that is, binding energy + kinetic energy of the captured neutron). It would, however, be experimentally very difficult to compensate the great differences in binding energy by using neutrons of different energy. In any event, such comparisons are not very significant, as with increasing neutron energy, other effects, such as inelastic scattering of neutrons, *n*—2*n* reactions, as well as the contributions of neutrons of high angular momentum, become important.

In the meantime, however, a number of binding energies have become known through the determination of the energy liberated in (*d,p*) reactions. Although they do not yet give information about nuclei heavier than arsenic, they show that no direct link between binding energy and $\overline{\sigma_{\text{cap}}}$ can be established. A similar impression is conveyed by the results of Allen and others[5], who determined the ratio of $\overline{\sigma_{\text{cap}}}$ for neutrons of 900–220 keV. for twenty-three elements.

There seems, therefore, little doubt that we are faced with a contradiction between existing qualitative and quantitative theories on one hand, and experimental facts on the other. While it might be argued that there are only a few nuclei which show these marked deviations from the general trend of $\overline{\sigma_{\text{cap}}}$, existing theories do not allow for such variations.

L. E. Beghian
H. H. Halban

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Oct. 11.

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[2] Kapur and Peierls, *Proc. Roy. Soc.*, A, 166, 277 (1938).

[3] Feshbach, Peaslee and Weisskopf, *Phys. Rev.*, 71, No. 3, 145 (1947).

[4] Griffiths, J. H., *Proc. Roy. Soc.*, A, 170, 513 (1939). Booth, E. T., and Hurst, C., *Proc. Roy. Soc.*, A, 161, 248 (1936). Halban, H. H., and Kowarski, L., *Nature*, 143, 392 (1938); owing to an arithmetical slip, the cross-sections are too small by a factor of twenty; war conditions made correction impossible. Hughes, D. J., Radiative Capture Cross-sections for Fast Neutrons. Manhattan District Publications, MDDC 27. Cohen, S. G., *Nature*, 161, 475 (1948). Segré, E. (quoted by Feshbach, Peaslee and Weisskopf).

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Particles with Spin and the Principle of Reciprocity

Following a suggestion of Prof. Max Born and Dr. H. S. Green, we have extended their theory of ultimate particles, recently published in *Nature*[1], to the case of spin ½.

The metric operator, which in the case of spin 0 or 1 was $S = x^k x_k + p^k p_k$, is now

$$S = (p^k + i\gamma x^k)\alpha_k, \tag{1}$$

where α_k ($k = 1, 2, 3, 4$) is a set of Dirac matrices and $\gamma = \alpha_1\alpha_2\alpha_3\alpha_4$. Its reciprocal property is expressed by the equation

$$S(x_k, p_k) = T^{-1} S(p_k, -x_k)T, \tag{2}$$

where $T = \frac{1+i\gamma}{\sqrt{1+i}}$, and one obtains all self-reciprocal functions as solutions of the equation

$$S\mathbf{F} = \mathbf{F}s, \tag{3}$$

where s is an eigen-symbol depending only on γ.

These solutions can again be expressed in terms of Laguerre polynomials $L_n{}^k(P)$, where $P = p_k p$;^{k} it is convenient to write them separately for the two eigen-values ± 1 of γ, namely,

$$\mathbf{F}_1 = 2\{(\alpha_r p^r)\,L_n{}^{k+2}(P) \pm \sqrt{n-k-1}\,L_n{}^{k+1}(P)\}\,(\alpha_r p^r)^k e^{-P/2} g, \tag{4}$$

$$\mathbf{F}_2 = 2\{(\alpha_r p^r)\,[L_n{}^{k+1}(P) - L_n{}^{k+2}(P)] \pm \sqrt{n+1}\,L_n{}^{k+1}(P)\}\,(\alpha_r p^r)^k e^{-P/2} g, \tag{5}$$

where g is a three-dimensional spherical function depending on the direction of the 4-vector p_r; n has the values 1, 2, 3, . . ., while $k = 0, 1, 2, \ldots n - 1$.

The roots of the equations $\mathbf{F}_1 = 0$, $\mathbf{F}_2 = 0$ are as before, the mass factors $\varkappa^2$ from which the real masses are obtained:

$$\mu = \frac{\hbar\varkappa}{ca}, \quad \text{and with } a = \frac{e^2}{mc^2}$$

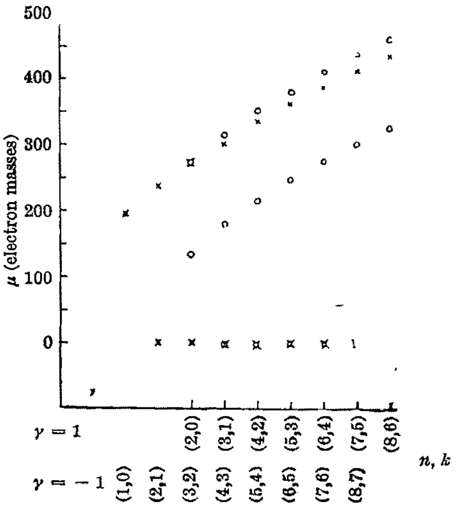
one has $\dfrac{\mu}{m} = \dfrac{\hbar c}{e^2}\,\varkappa = 137\varkappa$. Following Born and Green, we shall regard m as the mass of the electron.

As the expressions (4) and (5) have both the factor $(\alpha_r p^r)^k$, it follows that for odd $k > 1$ the theory predicts the existence of neutrinos satisfying

$$\alpha_r p^r = 0. \tag{6}$$

As already said in the previous communications, it seems to be very likely that the same factor represents electrons as charged neutrinos, the finite mass of which is due to the self-energy of the electromagnetic field produced by the charge. A preliminary proof of this has been given by Dr. Green.

For even k, one has particles satisfying the same equation as photons, $(\alpha_r p^r)^2 = p_r p^r = P = 0$, but with different spin properties.



Then there are a great many other particles, mesons with spin ½, the masses of which are obtained by putting the brackets in the expressions (4) and (5) equal to zero and solving for P. The values of $\varkappa$ for these are given in the accompanying table, and the rest-masses represented in the diagram.

For $\gamma = 1, k = n - 2$

n	
2	1
	2
3	0
	1·30
	2·30
4	0
	1·56
	2·56
5	0
	1·79
	2·79
6	0
	2
	3

For $\gamma = -1, k = n - 1$

n	
1	1·41
2	0
	1·73
3	0
	2
4	2·23
	2·23
5	0
	2·45
6	0
	2·64

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Thermal Conductivity of Superconductors

MEASUREMENTS have recently been made in this Laboratory of the specific thermal conductivity at liquid helium temperatures of a series of tin specimens, ranging from spectroscopically pure tin to alloys containing up to 4 per cent of mercury. A tantalum specimen was also measured. The apparatus was based upon the design of de Haas and Rademakers[1], with a pair of gas thermometers measuring the temperature at two points on a rod carrying a known heat power. An innovation was the use of the thermometers differentially, the pressure difference being indicated on a butyl phthalate oil manometer read with a travelling microscope. A much finer resolution was possible than in previous work[1,2], thus enabling accurate measurements of thermal conductivity to be made with temperature differences of only 0·01° K. Consequently a careful survey could be made of the

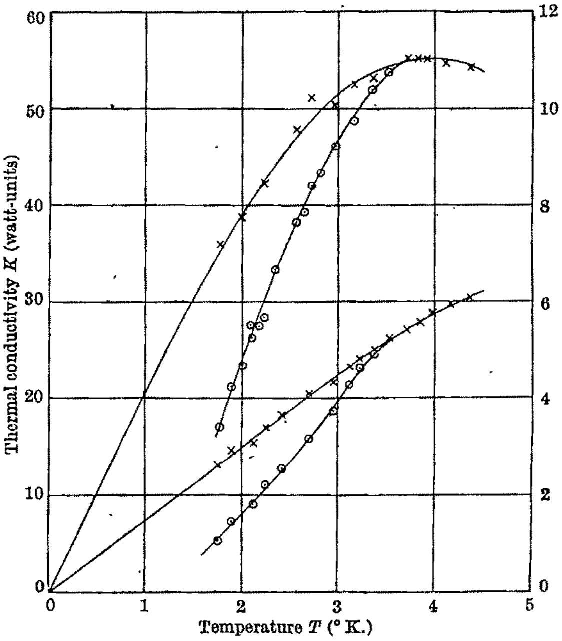

Fig. 1. Left-hand scale and upper curves, Sn2. Right-hand scale and lower curves, Sn3. ×, Normal curve; ⊙, superconducting curve

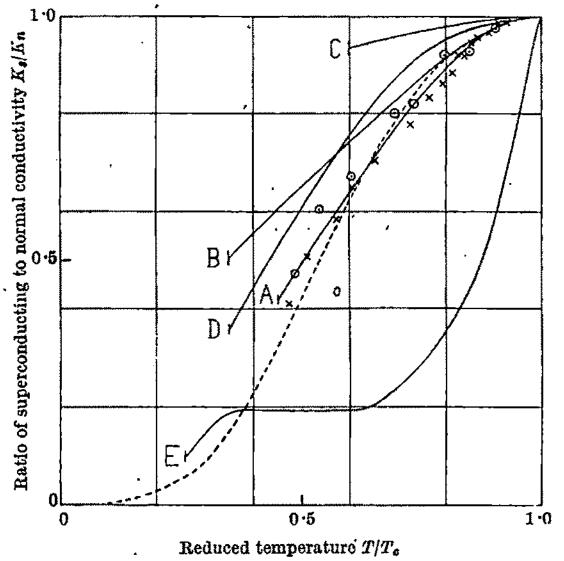

Fig. 2. Curve A, { ⊙ Sn2, 0·003 per cent impurity, K_n = 55·3 at T_c. × Sn3, 0·033 per cent mercury, K_n = 5·49 at T_c. }
Curve B, Sn6, 0·33 per cent mercury, K_n = 0·628 at T_c.
Curve C, Sn9, 4·1 per cent mercury, K_n = 0·124 at T_c.
Curve D, tantalum, K_n = 0·0501 at T_c.
Curve E, lead, K_n = 4·28 at T_c (ref. 1).
Dotted curve, Heisenberg theory.
(The experimental points are omitted from curves B, C and D, the scatter being of the same order as for Sn2 and Sn3)

region close to the superconducting transition temperature. The thermal conductivity was measured in both superconducting and normal state, the latter by destroying superconductivity with a longitudinal magnetic field. In the case of very pure tin, the magnetic field produced a large variation of conductivity in the normal state, and extrapolation was necessary to derive the value in zero field.

Typical conductivity-temperature curves are shown in Fig. 1 for spectroscopically pure tin (Sn2) and tin containing 0·033 per cent of added mercury (Sn3). According to Makinson[3], the electronic thermal resistance of a pure metal may be expressed as the sum of lattice vibration scattering and impurity scattering terms, $\alpha T^2 + (\beta/T)$, and this formula was found to represent the results for the normal state quite well. The initial slope of the conductivity curves gave values of β in good agreement with the theoretically predicted values ρ_0/L_0, where ρ_0 is the residual electrical resistance and L_0 the Lorenz number.

The ratio of superconducting to normal conductivity is plotted in Fig. 2 as a function of the reduced temperature T/T_c, where T_c is the transition temperature. No discontinuity is apparent in the curve or its gradient at the transition point, but the values of K_s/K_n for Sn2 and Sn3 fall on a single curve, in spite of the very large difference in the absolute values of their conductivities; this suggests that the ratio may be a characteristic function of temperature. It is interesting to note that a universal function of this kind proposed by Heisenberg[4] and shown dotted in Fig. 2 is in fair agreement with the experimental data.

On the basis of this concept, the departures for the less pure specimens Sn6 and Sn9 from the curve for Sn2 and Sn3 may be interpreted as due to the additional heat transport through the ionic lattice itself, which may reasonably be assumed to be independent of whether the metal is superconducting or normal. This additional contribution would naturally become important for specimens in which the low purity gives rise to a low electronic conductivity; on the assumption that the ratio of the superconducting to normal electronic conductivities is given by the Sn2 and Sn3 curve, a new method of estimating the lattice conductivity is provided, the values so obtained for Sn6 and Sn9 being consistent and of a reasonable order of magnitude.

The tantalum specimen shows the same general behaviour as tin, but the curve of K_s/K_n departs somewhat from the curve for pure tin. If, as suggested above, there is a universal curve for K_s/K_n as a function of reduced temperature which applies to all superconductors, the difference between the tantalum and pure tin curves can probably be attributed, as in Sn6 and Sn9, to heat transfer by the lattice itself.

The K_s/K_n curve for lead[1] is also shown in Fig. 2 and does not contradict the idea of a universal ratio curve if this is assumed to apply only to impurity scattering (responsible for the β/T term in Makinson's expression for the normal conductivity). Comparison of Makinson's formula with the normal curve for lead indicates that lattice vibration scattering (responsible for the αT^2 term) is predominant except at the lowest temperatures. The abnormally low values of K_s/K_n at higher temperatures may perhaps be interpreted as indicating that scattering of electrons by lattice vibrations is much more effective in the superconducting than in the normal state. The K_s/K_n values for lead are roughly in agreement with the Heisenberg curve at the lowest temperatures where impurity scattering is the main process.

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Jan. 13.

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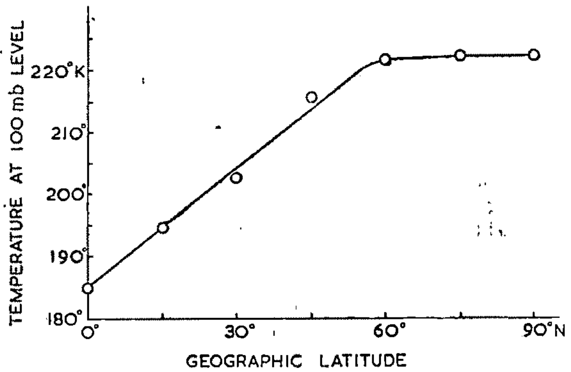
Latitude Effect and Pressure-Level of Meson Formation

Kupferberg[1] first, and later on Rathgeber[2], have both directed attention to the possibility that the latitude effect of cosmic rays due to the geomagnetic field may be partially masked by the fact that the height of the pressure-level of meson formation increases towards the equator. In particular, Rathgeber has shown, by taking 100 mb. for this pressure-level, that owing to this increase, the intensity of mesons at sea-level at mean latitudes should exceed the intensity at the equator by 3 per cent. The magnetic latitude effect would therefore be reduced from 10 to 7 per cent.

I wish to point out that a further correction must be applied as a consequence of the increase with latitude of the temperature at the level of meson production. I reported at the Bristol Symposium on Cosmic Radiation last September that the temperature at this level, or its equivalent the density, appears to be a factor closely controlling the meson intensity at sea-level. The intensity at sea-level increases with increasing temperature or decreasing density at the rate of 0·11 per cent per ° C., that is, at the rate of about $-0\cdot22$ per cent for a change of air density at the region of production of $1\cdot0$ per cent. Further measurements made in the last two months have entirely confirmed the reality of this result. A detailed account of this will appear elsewhere. Since the temperature at the 100 mb.-level increases with latitude, we may expect, therefore, a greater intensity at sea-level of μ-mesons in mean latitudes than in the equatorial region. The accompanying figure gives the annual mean temperature of the 100 mb.-level, as obtained from the vertical distribution of temperature in summer and winter, according to Haurwitz and Austin[3]. It will be seen that the difference in temperature between the plateau above lat. 60° and the value at the equator amounts to about 36° K. This difference, multiplied by the coefficient $0\cdot11$ per cent given above, leads us to expect that the intensity of mesons would increase from the equator to latitude 60° by 4 per cent. Allowing for this increase, as well as that obtained by Rathgeber, the magnetic latitude effect would, therefore, be reduced to the small value of 3 per cent.



We may note, however, that in making these corrections it has been assumed that the mesons are formed at the same pressure-level in all latitudes. This seems to be the general belief, but it has not yet been proved. Indirect evidence that the bulk of the penetrating component is formed in the proximity of the 100 mb.-level in mean latitudes has been given[4], but no evidence exists, so far as we know, that this is so in the equatorial region. On the other hand, if mesons are produced by primary protons, it is plausible to expect that the region of production lies at greater depths at the equator, since the incident proton will have a greater energy at the equator and so may penetrate deeper into the atmosphere than those at higher latitudes, which will be of lower energy.

If, therefore, we assume that the mesons are formed at a pressure-level lower than 100 mb. near the equator, it may be seen that the atmospheric effects under consideration would result in the two corrections being opposite in sign.

Let us assume, for example, that the production-level at the equator is at 125 mb. From meteorological observations, the mean height of this pressure-level appears to be $15\cdot1$ km., while that of 100 mb. at lat. 45° is $16\cdot1$ km. Neglecting the change in energy spectrum, the difference in intensity due to decay of ordinary mesons would be given with sufficient approximation by the ratio of the difference in height to the mean range L. Thus, with the value $18\cdot6$ km. formerly found for L; $I_{45°} - I_{\text{Eq.}} = (15\cdot1 - 16\cdot1)/18\cdot6 = -5\cdot4$ per cent.

To estimate the effect of density, we will take the temperature at 125 mb. at the equator to be 196° K., and that at 100 mb. at lat. 45° to be 215° K. The relative densities at the two levels will be proportional to the pressure divided by the temperature, and so will be proportional to $100/215 = 0\cdot465$ and $125/196 = 0\cdot638$. The relative difference in density expressed as a percentage of the mean will be $200\ (0\cdot465 - 0\cdot638)/(0\cdot465 + 0\cdot638) = -31\cdot4$ per cent. With the density coefficient $-0\cdot22$ per cent per 1 per cent of density given above, we should have on account of this effect $I_{45°} - I_{\text{Eq.}} = +6\cdot9$ per cent.

The two atmospheric effects taken together would give $I_{45°} - I_{\text{Eq.}} = -5\cdot4$ per cent $+ 6\cdot9$ per cent $= +1\cdot5$ per cent.

Had we assumed 150 mb. for the production-level in the equatorial region and so a height of $14\cdot2$ km. and a temperature of 205° K., the sum of the two effects would have given $I_{45°} - I_{\text{Eq}} = -10\cdot2$ per cent $+ 9\cdot8$ per cent $= -0\cdot4$ per cent.

It may well happen, therefore, that the latitude effect as observed at sea-level is almost entirely due to the deflecting action of the geomagnetic field, owing to the accidental cancelling of the corrections due to the height and to the temperature of the production level. It will only be possible, however, to determine accurately the magnetic latitude effect when the variation of the height of the level of formation with latitude has been determined.

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Jan. 21.

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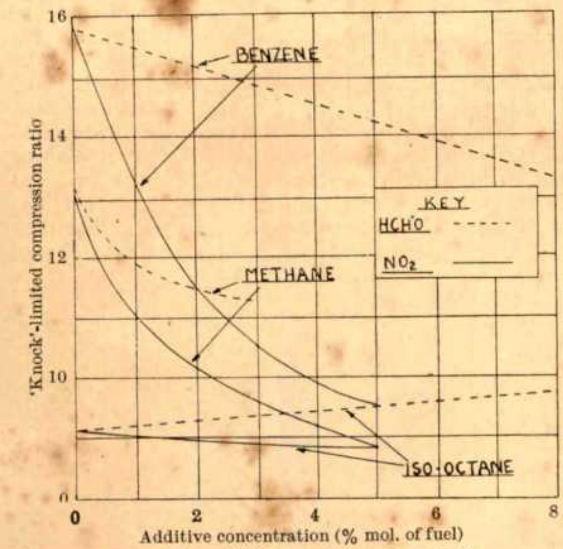
'Knock' in Internal Combustion Engines

WORK on the effect of additives on the 'knock'-limited compression ratios of a wide variety of fuels has shown that there are at least two mechanisms whereby a fuel may 'knock'. One appears to correspond to the 'high'- and one to the 'low'-temperature ignition process discovered[1] and thoroughly explored[2] by Townend and his co-workers. Hydrocarbons such as benzene and methane, which Townend did not observe to give a 'low'-temperature ignition peninsula, 'knock' by the 'high'-temperature process, and other hydrocarbons 'knock' by the 'low'-temperature process.

Using a Ricardo E.6 variable-compression engine, we have obtained curves of 'knock'-limited compression ratio (determined aurally) against concentration of additive. In the course of work with a very large number of additives (the full results of which will be published elsewhere) we have found that in benzene and methane, formaldehyde and nitrogen peroxide are strong pro-knocks, whereas in *iso*-octane, formaldehyde is an anti-knock and nitrogen peroxide has only a very slight pro-knock effect (see diagram). The differential effects of these dopes in the two classes of hydrocarbon correlate well with their effect on the 'high'- and 'low'-temperature modes of oxidation respectively[3,4]. The effect of these additives in hydrogen is similar to their effect in benzene and methane.



Tests on formaldehyde and nitrogen peroxide

In addition, we have found that both methane and hydrogen have considerable lead responses. The latter result differs from that of Egerton, Smith and Ubbelohde[5], who found tetraethyl lead to have no effect in hydrogen. It may be that the results of Egerton *et al.* were complicated by the incidence of pre-ignition, which is difficult to exclude when working with hydrogen.

This work was carried out in the Ricardo Laboratory on behalf of the Shell Petroleum Co.

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Ricardo and Co. (Eng.), 1927, Ltd.,
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[2] See Newitt and Townend, "The Science of Petroleum", **4**, 2884, 2958 (1938).

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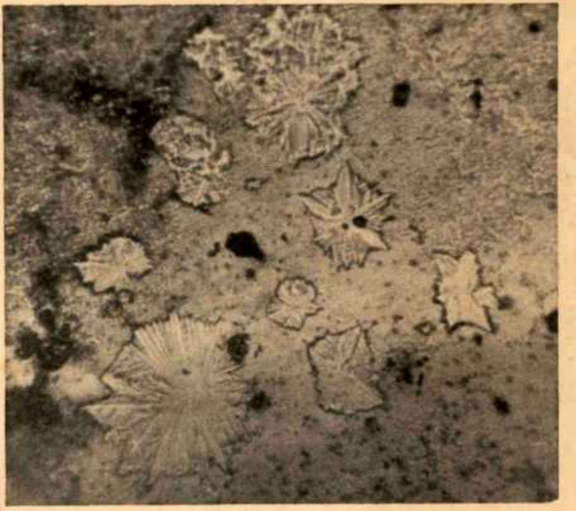
Hydrolysis of Starch Grains by Polarized Infra-Red Radiation

AT the Liverpool meeting of the British Association in 1923, it was shown that polarized radiation had the effect of accelerating the change of starch grains, in a *weak* suspension of diastase and at ordinary laboratory temperature, into a crystalline reducing substance; but if the diastase were active or concentrated, no *selective* effect was observed[1]. Earlier experiments in 1922 had shown me that, when ground cereals in plain tap water were exposed to this radiation, a portion of the starch was turned to sugar. This was estimated by Bertrand's method[2]. To meet criticism that the effect might be due to the pressure of the cover glass, the experiment was repeated; but instead of using a microscope slide, the starch suspension was in a flat-bottomed, very thin-walled flask, the base of which was irradiated by light, polarized and reflected vertically upward by a suspension of diastase in an *outer* vessel[3].

The resulting hydrolysis was so remarkable that, not only did it dispose of the cover-glass theory, but also it suggested that the polarization of the incident radiant energy by the diastase was the important *physical* factor in enzymatic hydrolysing action; for the enzyme was not in contact with the substrate.

Hydrolysis without enzyme. Prof. E. C. C. Baly pointed out to me that the absorption bands, both of water and the carbohydrate groups, were in the short infra-red. Fused silica ('Vitreosil') dishes, which transmit these rays, have now been used. Radiation from an electric spiral or small radiator was reflected by black glass or by ferrotype at the polarizing angle, striking the underside of the dish containing a suspension of well-washed potato-starch grains. After a period of about seven hours, the grains in some places had a dull, swollen appearance. On drying, clusters of crystals were seen exuding from the grains, or totally escaped into the surrounding medium (see photograph). The temperature was usually only one, or sometimes two, degrees above the room temperature (generally about 19° C.).



The addition in later experiments of a trace of sodium chloride (0–0·3 per cent) greatly increased the effect. In this case, the crystals often formed *within* the grain, the coat of the grain gradually disappearing. The sodium chloride apparently acted as a co-enzyme.

The contents of the dish were washed out with distilled water, and, when tested in the usual way, gave evidence of sucrose.

If the experiment is done during the months when the potato tubers are in a dormant condition, the control, placed by the side with ordinary radiation, gives intact starch grains; but after February some crystals may be found and a few of the grains will be seen breaking.

The similarity of the results, though in a much smaller degree, indicates that in this experiment we are imitating the natural process of enzyme hydrolysis.

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RADAR OBSERVATION OF HEAVY RAIN

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WHILE a certain amount of data on radar observations of tropical rain has been published, the accompanying photographs of a radar P.P.I. screen showing a belt of heavy rain passing over the Manchester district may be of interest. The wavelength used was 3 cm. and the pulse length 1 microsecond, the photographs being taken on the afternoon of Friday, November 19, 1948, approximate times only being given.

Fig. 1 is a tracing of the P.P.I. picture with the coast-line and certain known points plotted by range and bearing for identification purposes. The radius of the display is about 40 miles.

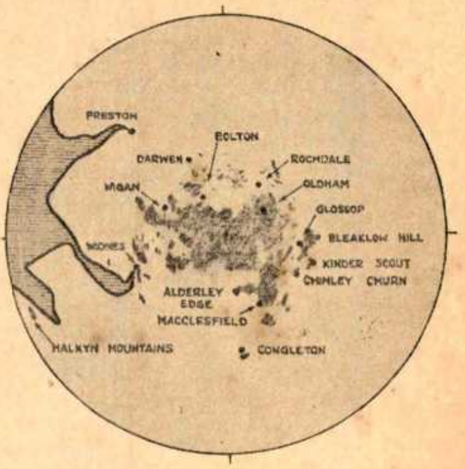


Fig. 1

Fig. 2 is a photograph, taken at 2.50 p.m., showing a belt of rain more than 30 miles long forming in the west.

Fig. 3 was taken at 3.30 p.m. Note how the rain is moving to the east, giving very strong echoes, the belt being continuous for more than 50 miles. Although not very obvious in the photograph, the centre of this belt is curved backwards, presumably being delayed by the high ground in the Wigan area.

Fig. 4 was taken at 4.20 p.m. The rain belt has passed over Manchester and is much shorter. Note the secondary belt of rain following the main one, and the apparent attenuation of the normally strong echo from the hill (Mow Cop) just south of Congleton, possibly due to the two rain belts across this path.

Fig. 5 was taken at 4.35. The belt has lengthened slightly and the centre is again delayed, possibly due to the high land in the Peak District. A further photograph was taken at 4.45 p.m., which showed that the rain had passed the Peak and appeared to be weaker; this may be due to the masking effect of the hills as the rain passes below the horizon.

The general speckled background in most of the photographs is the effect of receiver noise in the radar system.

The echoes received are from very heavy rain. The observed belt arrived in Manchester a little before 4 p.m. and was preceded by about five miles of light rain. At this period, Ringway Airport reported that 4 mm. of rain fell in 35 minutes. Light rain persisted for more than an hour after the heavy rain passed over.

Fig. 2

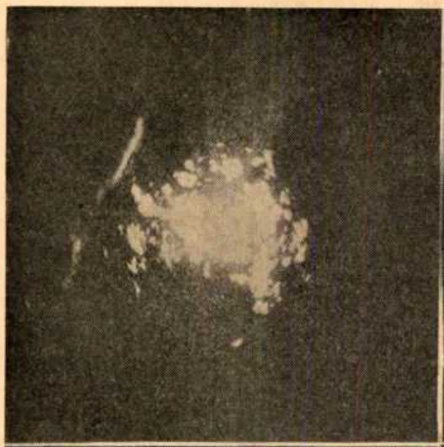
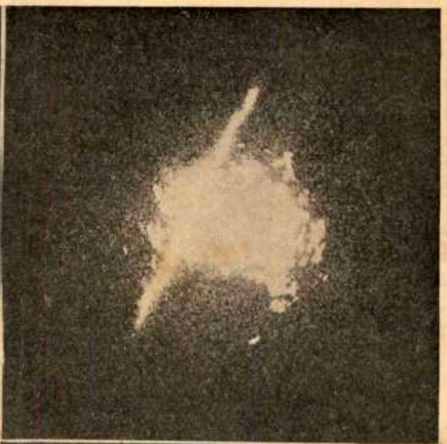


Fig. 3



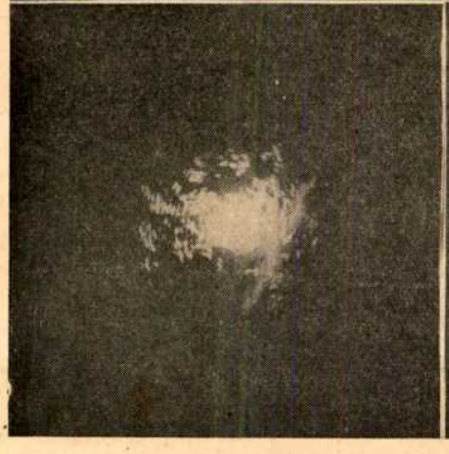


Fig. 4

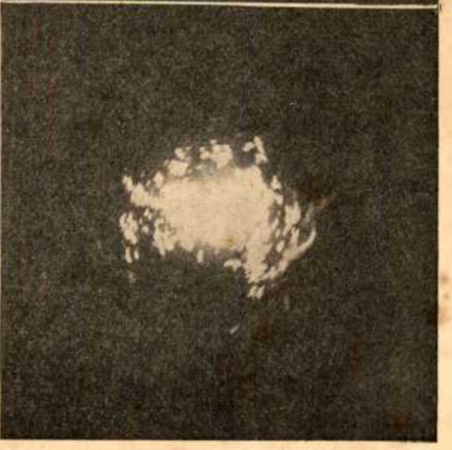


Fig. 5

UNIVERSITY TRAINING OF ZOOLOGISTS

AT a recent meeting in the rooms of the Zoological Society of London, the Association of British Zoologists held a discussion on the training of zoologists in the university, giving an opportunity to discuss the address which its president, Prof. H. Graham Cannon, had delivered when presiding over Section D of the British Association at Brighton last September. A large attendance of members pointed to the interest which this subject clearly has for zoologists at the present time.

The discussion was begun by Prof. D. M. S. Watson, who outlined the historical development of courses of zoology in London since they were first begun by Grant at University College in 1828. During the second half of last century, there took place the gradual establishment of the 'type' system, largely due to the work of Huxley at the Royal School of Mines and the Normal School of Science, and to that of Ray Lankester at University College; and this has survived to the present day as the basic plan upon which courses for degrees in zoology are built. As Prof. Cannon had pointed out in his address at Brighton, there was in the nineteen-twenties a general revolt against the dominating position of comparative anatomy in zoological education, and Prof. A. C. Hardy illustrated from the arrangement of courses in the Department of Zoology at Oxford how much time had now to be devoted to other parts of the subject. During the period 1943–45, 71 per cent of the lectures were allotted to a systematic treatment of the various groups of the animal kingdom, and the remaining 29 per cent to such general topics as ecology and the distribution of animals, genetics, evolution, physiology, embryology, cytology and histology. For the years 1946–48, the figures were markedly different—45 per cent only of lectures were devoted to a morphological treatment of groups; another 45 per cent to the general topics mentioned above, while the remaining 10 per cent went to a course on the history of zoology and to discussion of research topics, a weekly debate on controversial subjects. It seems doubtful, he said, whether the treatment of groups can be profitably or desirably reduced from this, as an understanding of their anatomy and relationships is necessary for the proper treatment of the more general part of the course.

Prof. Hardy emphasized that a course on zoology such as this is essential for the training of professional zoologists: for the general education of the university student reading other subjects, he was prepared to agree with Prof. S. Mangham, who addressed the Association on the recent memorandum prepared by the Association of Scientific Workers on the teaching of biology in universities. This memorandum proposes what is, in effect, the disappearance of separate university departments and courses of botany and zoology, and their replacement by a single integrated department and course of biology, on the ground that world conditions emphasize the need for a new approach to social and food problems, and that this could be well achieved through biology. A biological training, too, would produce not only good technicians but also good citizens, and so could well become a regular part of the curriculum for arts as well as for all kinds of science degrees. So far as the content of the courses was concerned, there was suggested the same kind of distribution of emphasis as indicated by Prof. Hardy (and which later discussion showed was, in fact, general throughout the universities)—a reduction in the teaching of evolutionary morphology, the time thus gained being used to give a more generous treatment of ecology, genetics, physiology, parasitology, human biology and the history of science.

Mr. H. W. Parker, speaking on the needs of the museums, emphasized that they require *educated* zoologists. The fields of knowledge needed in a museum zoologist's career would appear to be essentially compatible with a good general education, and no radical changes in the present zoological courses are called for, though changes of emphasis and timing might be beneficial. For example, natural history, being ill suited to laboratory methods, receives insufficient attention, and taxonomy is out of fashion now that the pertinent question is "How does evolution take place?" rather than "Has it taken place?" Yet, although geneticists and others may show how evolution can take place, the taxonomist can show how it has done so, or is doing so now. Greater taxonomic training would also lead to greater appreciation of the vast range and complexity of animate Nature, a matter which the 'type' system under-emphasizes. Museums must obtain recruits with knowledge suitable for developing new lines of attack: the scant attention by taxonomists to myology, compared with osteology, Mr. Parker said, reflects the different emphases on these two subjects in the universities, and the preponderant attention to marine zoology in most courses has repercussions in the museums. For the proper understanding of the relationships of recent animals, knowledge of the environmental conditions of the immediate past is essential, and this calls for acquaintanceship with geophysics and climatology. Finally, since abiding interests develop more readily in familiar than in unfamiliar fields, Mr. Parker pressed for greater collaboration and for the encouragement of students to visit and actually work in the museums.

RELATION OF A CLOVER JUICE FACTOR CAUSING PARALYSIS OF SMOOTH MUSCLE TO BLOAT IN RUMINANTS

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FERGUSON[1] observed that whereas the juices of the most prevalent pasture grasses in Great Britain had little effect on the isolated rabbit intestine, those from certain legumes (for example, clover, lucerne) caused relaxation and paralysis. He excluded the possibility of certain inorganic ions, protein and alkaloid components from being responsible for this phenomenon. The importance of this finding in problems associated with the 'pasture-grazing animal' interrelationships is apparent.

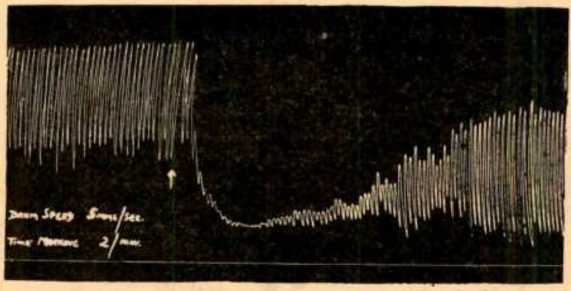

Fig. 1. Typical tracing of rabbit intestine treated with clover juice (2 ml. added to the Tyrode bath of capacity 50 ml.). Similar results obtained with known cytochrome poisons, see text

The cause of bloat, fog-fever, and ruminal atony in cattle and sheep, together with tympanitic colic and grass-sickness in horses, has not yet been established, although a particular pasture environment is usually incriminated. In bloat[2], it is believed that there is an inhibition of the eructation reflex associated with ruminal stasis; the animal being unable to belch, cannot void the gases produced in the paunch as a result of fermentation.

Working with the leaf juice of a white clover, we have shown that one of the factors responsible for the effect on the rabbit intestine is hydrocyanic acid. The evidence leading to this conclusion is as follows:

(1) The principle is absent from the residue of either the intact leaves or crude juice after drying at 100° C. in a well-ventilated oven.

(2) Separation of the crude juice into acid, neutral and basic fractions shows that the activity is concentrated in the ether-soluble acid fraction.

(3) Acidified clover juice was steam-distilled, and the distillate collected into ice-cold alkaline Tyrode solution. The distillate possessed the whole of the activity of the juice when tested on the rabbit intestine. It also gave all the chemical tests for a weak solution of hydrocyanic acid. The same acidified clover juice, treated similarly with respect to temperature, in a sealed tube, showed comparable activity with the original, after cooling and neutralization, but in an open tube had lost all activity. This illustrates the volatility of the factor, which caused erratic results in its concentration, until steps were taken to counter it.

(4) Crude clover juice, and a solution of hydrocyanic acid of the same CN′ concentration (estimated by the method of van der Walt[3]), produced almost identical responses on the isolated rabbit intestine (Fig. 1).

Several substances, both synthetic and of natural origin, were tried for their action on the isolated rabbit intestine; the well-known poisons of the cytochrome system all produce a response similar to that shown in Fig. 1, namely, for small doses, relaxation, and diminution of amplitude, with subsequent recovery, but with increased dosage, irreversible paralysis in the relaxed state. The necessary concentrations differ widely: for example, sodium cyanide (1/100,000); sodium sulphide (1/2,000); sodium azide (1/2,000). Hydroxylamine (1/5,000) has a similar effect. Hydrotropic substances like sodium desoxycholate, and sodium taurocholate (1/5,000) and surface-wetting agents (for example, the detergents 'Cetavlon', 'Teepol'). also possess a well-marked relaxing effect leading in some cases to paralysis. Saponin (1/5,000) paralyses the rabbit intestine in the contracted state.

It is known that some pasture plants, especially legumes, may contain cyanogenetic glucosides (*Trifolium repens* contains lotaustralin and linamarin)[4] which produce hydrocyanic acid by hydrolysis with the appropriate enzyme. Again, hydroxylamine has been postulated as an intermediate in nitrogen metabolism by plants and bacteria. The analysis of rumen gases shows 0·1 per cent hydrogen sulphide to be a fairly normal figure, while Dougherty[5] reports the presence of carbon monoxide in concentrations up to 0·17 per cent. Certain plants, especially legumes, are rich in saponin-like substances.

We have already shown that one litre of clover juice (equivalent to about 5 lb. fresh clover) introduced directly into the rumen of a sheep paralysed its movements immediately. After some time, however, the animal showed general symptoms of acute poisoning, namely, dyspnœa, dilatation of the pupils, and finally succumbed in a tetanic convulsion 2 hr. after administration of the juice. The post-mortem findings were consistent with poisoning by hydrocyanic acid. Estimation showed 200 mgm. hydrocyanic acid per litre in the crude clover juice, which is double the lethal dose[6] for sheep of this size (Welsh Mountain, wt. 100 lb.). During the first 90 min., no ruminal movements were recorded; towards the end they were re-appearing again spasmodically but with diminished force (Fig. 2).

In an attempt to produce bloat in the field, three two-year-old Welsh Black cattle (a bullock and two heifers), starved for 12 hr., were turned to graze a white clover pasture. The three animals grazed the clover avidly for 15 min.; the two heifers then stopped, stood listlessly for a while, and then wandered and grazed rough herbage other than the clover, which they deliberately avoided. The bullock persisted with the clover grazing for a further 5-min. period, and then behaved as the heifers had done. Within a period of 30 min. the bullock showed definite

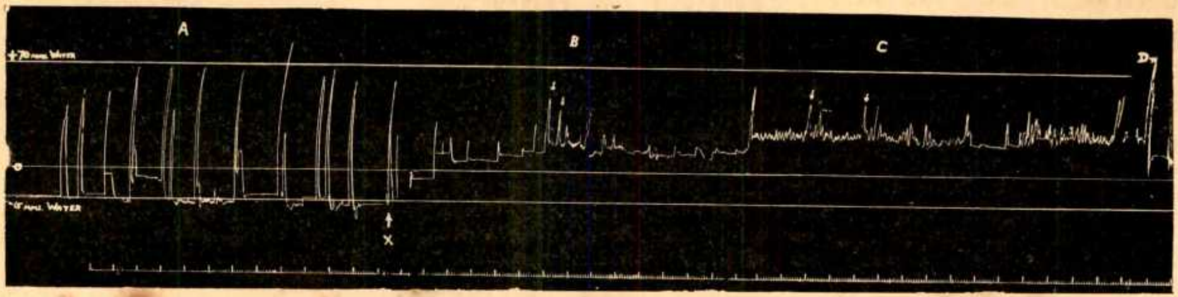

Fig 2. *A*: Normal rumen activity. Drum speed, 5 mm./min.; time marker, 10 per min. *X*: Point of introduction of clover juice (1 litre). *B*: Tracing after addition of the juice. *C*: One hour after dosing, showing rapid respiratory movements and the re-appearance of spasmodic rumen contractions (arrows). *D*: Denotes a marked increase in pressure, when sheep was in a convulsive state

symptoms of distress (respiration 95 per min., pulse 120 per min.) and was slightly blown; the heifers, although full in the flank, were neither blown nor showing signs of discomfort. Blood samples taken at this stage were analysed for hydrocyanic acid content; the bullock's blood contained 0·1 mgm. hydrocyanic acid per 100 ml. blood, while the heifers' had 0·04 mgm. per 100 ml. blood.

The possible role of hydrocyanic acid in the etiology of acute bloat in sheep has been considered before by Clark and Quin[7], but they prefer the 'saponin foam theory' of its pathogenesis (see also Clark[8]).

It seems probable to us that in a complex syndrome like bloat several factors may operate; a satisfactory theory of the cause must not only account for the sequence of symptoms in the animal, but must also explain observations of agriculturists on predisposing environmental conditions. We believe that our findings are significant in this connexion.

We wish to acknowledge our grateful thanks to the Welsh Plant Breeding Station for providing facilities in the field.

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DETERMINATION OF ABSOLUTE INTENSITIES OF X-RAY REFLEXIONS FROM RELATIVE INTENSITY DATA

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RECENTLY, owing to the advent of various methods[1] of direct determination of phase angles of Bragg reflexions from a crystal, a convenient method of determination of absolute intensities of Bragg reflexions seems urgently needed[2]. In 1942 I proposed a simple method of determination of absolute from relative intensities[3], which has since been made rigorous and so should be reliable in general cases if used properly. Accordingly, I present here the final result of the method, which is applicable to practical cases immediately.

Suppose we have a crystal containing t atoms in the unit cell, the number of shell electrons of the ith atom being Z_i. Let the relative intensities of reflexions for the crystal at room temperature be denoted by $I'(hkl)$ for hkl and $I'(000)$ for 000. We have

$$|F(hkl)|^2 = \frac{F^2(000)}{I'(000)} I'(hkl). \tag{1}$$

We see that if we can determine $I'(000)$ we can deduce $|F(hkl)|^2$ from $I'(hkl)$, for we have the known $F(000) = \sum_{i=1}^{t} Z_i$. Let us introduce

$$\bar{f}(hkl) = \sum_{i=1}^{t} f_i(hkl) \Big/ \sum_{i=1}^{t} Z_i, \tag{2}$$

where $f_i(hkl)$ is the atomic structure factor at room temperature of the ith atom in the cell. If only $f_i(hkl)$ for atoms at rest are available, such as those obtained from James and Brindley's table, suitable temperature correction must be made in order to obtain the room temperature value of $f_i(hkl)$. We further form the sum $\sum_{i=1}^{t} Z_i^2$. Then from the theory of a new X-ray synthesis developed by me, it can be shown that:

$$I'(000) = F^2(000) \frac{\Sigma' U_{n_1h} U_{n_2k} U_{n_3l} I'(hkl)/\bar{f}^2(hkl)}{\sum_{i=1}^{t} Z_i^2 - U_{n_10} U_{n_20} U_{n_30} \cdot F^2(000)}, \tag{3}$$

where Σ' denotes the sum $\sum_{h=-\infty}^{\infty} \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty}$, excluding the term of $h = k = l = 0$. U_{nh} are known functions of n and h, the numerical values of which are negligibly small for $h > n/2$; $U_{nh} = U_{n\bar{h}}$ when $\bar{h} = -h$. Thus, if the maximum h, k, l of our available set of $I'(hkl)$ are h_M, k_M, l_M, we may choose $n_1 \doteq 2h_M$, $n_2 \doteq 2k_M$, $n_3 \doteq 2l_M$. The values of U_{nh} for some values of n and h are given below:

$U_{nh} \times 10^4$

n / $\pm h$	48	44	40	36	32	28	24	20	16	12
0	334	364	400	443	498	568	660	790	981	1297
1	325	354	388	430	481	547	633	751	920	1187
2	315	341	371	409	455	511	584	679	809	989
3	303	328	357	391	433	484	547	626	729	848
4	294	316	342	372	407	449	499	557	617	646
5	282	303	327	354	386	421	462	505	540	528
6	272	291	311	334	360	387	414	433	422	176
7	256	278	296	316	338	359	377	385	360	
8	251	265	280	296	312	324	328	308	131	
9	239	253	266	278	290	297	294	272		
10	230	240	250	258	263	261	240	104		
11	218	227	235	240	242	235	216			
12	209	215	219	220	215	196	87			
13	198	202	204	203	196	181				
14	187	189	189	181	164	73				
15	177	177	174	167	155					
16	166	164	157	142	64					
17	156	152	145	135						
18	144	138	124	57						
19	135	128	120							
20	122	110	51							
21	115	108								
22	99	46								
23	98									
24	42									
ΣU_{nh}	0·9998		1·0010		1·0016		1·0022		1·0037	

The last row gives the sum $\sum_{-h_M/2}^{h_M/2} U_{nh}$ for $n = 48$, 40, 32, 24, 16. Apparently all the sums differ from the theoretical limit $\sum_{h=-\infty}^{\infty} U_{nh} = 1$ only by fractions of 1 per cent, indicating the rapidity of convergence of the infinite series.

The accuracy of $I'(000)$ deduced from (3) depends essentially upon the following four factors:

(1) The accuracy of the observed $I'(hkl)$.

(2) The order of approximation of the equation

$$f_i(hkl) = Z_i \cdot \bar{f}(hkl), \tag{4}$$

which forms the basis of equation (2). The error introduced by the failure of equation (4) is usually not very serious.

(3) The proper correction of the temperature effect in $f_i(hkl)$. If we actually do a suitable experiment to correct this effect, the error introduced is, of course, limited. Otherwise we have to correct the effect with reference to similar crystals of known structures, and

the error resulting in $I'(000)$ may be very large. This uncertain correction of the temperature effect constitutes the chief source of errors in the value deduced for $I'(000)$.

(4) The correct choice of n_1, n_2, n_3. The strict condition is

$$d_m \geqslant \frac{1{\cdot}2a}{n_1}, \frac{1{\cdot}2b}{n_2}, \frac{1{\cdot}2c}{n_3},$$

where d_m denotes the shortest interatomic distance between any two atoms in contact in the crystal. Because this condition is rather too strict to be satisfied easily, let us introduce a much more approximate condition,

$$\begin{aligned} d_a \geqslant\ & 1{\cdot}2 \left\{\left(\frac{a}{n_1}\right)^2 + \left(\frac{b}{n_2}\right)^2 + \frac{2ab}{n_1 n_2}\,|\cos\gamma|\right\}^{1/2}, \\ & 1{\cdot}2 \left\{\left(\frac{b}{n_2}\right)^2 + \left(\frac{c}{n_3}\right)^2 + \frac{2bc}{n_2 n_3}\,|\cos\alpha|\right\}^{1/2}, \\ & 1{\cdot}2 \left\{\left(\frac{a}{n_1}\right)^2 + \left(\frac{c}{n_3}\right)^2 + \frac{2ac}{n_1 n_3}\,|\cos\beta|\right\}^{1/2}, \end{aligned}$$

where d_a denotes the average interatomic distance between any two contact atoms in the crystal: d_a can be roughly estimated from the nature of the atoms contained. In case the structure contains a number of very heavy small atoms, their effect on $I'(000)$ can be estimated.

When all of the foregoing four points have been provided for, it is believed that the error in $I'(000)$ would fall in the range of 5–20 per cent in the usual cases.

To illustrate the use of (3), let us first take a crystal consisting of only one atom at the origin in the unit cell, the number of electrons in the shell of the atom being Z and the atomic structure factor, $f(hkl)$. Then $F(hkl) = f(hkl) = Z\bar{f}(hkl)$. $F^2(000) = Z^2$. If we assume $I'(hkl) = F^2(hkl)$, we have $I'(hkl)/\bar{f}^2(hkl) = Z^2$. Substituting these values in (3) we obtain

$$I'(000) = Z^2\,\frac{\left(\sum\limits_{h=-\infty}^{\infty} U_{n_1h}\right)\left(\sum\limits_{k=-\infty}^{\infty} U_{n_2k}\right)\left(\sum\limits_{l=-\infty}^{\infty} U_{n_3l}\right) - U_{n_10}U_{n_20}U_{n_30}}{1 - U_{n_10}U_{n_20}U_{n_30}}.$$

Using U_{nh} given in the table, with $n_1 = 48$, $n_2 = 32$, $n_3 = 16$, we obtain $I'(000) = 1{\cdot}0051Z^2$, which differs from the assumed $I'(000) = F^2(000) = Z^2$ only by 0·51 per cent. The choice of U_{nh} of any other n_1, n_2, n_3 will give similar results.

Let us next illustrate the method by studying a real crystal, say, *para*dinitrobenzene, the structure of which was determined carefully by James, King and Horrocks[4], who made the determination on the basis of intensities of reflexions $hk0$, $h0l$ and $0kl$. Strictly speaking, we should determine $I'(000)$ from equation (3), based on the relative intensities of the whole set of reflexions hkl. But in the case of the present structure, as we know already from James, King and Horrocks' paper that there is no overlapping of atoms directly upon each other in the projection of the structure in direction b to the ac plane (see ref. 4, Fig. 3), a study of the relative intensities of reflexions $h0l$ is sufficient for our purpose of illustration. Then let us take their observed $F^2(h0l)$ directly as our $I'(h0l)$ and take Robertson's f-values[5] directly as our $\bar{f}(h0l)$. Since no further temperature correction has been made, the values of $\bar{f}(h0l)$ so obtained are under-corrected for the temperature effect as revealed from my studies of the same structure. But we may deliberately use such rough values of $\bar{f}(hkl)$ in order to see if $I'(000)$ so deduced still proves reliable. The structure has

$$F^2(000) = 164^2\,, \quad \sum_{i=1}^{t} Z_i^2 = 1140$$

when the contribution of the hydrogen atoms is neglected. $h_M = 13$ such as in $h0l = 13\ 0\ 1$, and $l_M = 7$ such as in $h0l = 1\ 0\ 7$. Accordingly, we take $n_1 = 24$, $n_3 = 12$. The two-dimensional equation for $I'(000)$ is given by

$$I'(000) = F^2(000)\,\frac{\Sigma' U_{n_1h}\,U_{n_3}\,I'(h0l)/\bar{f}^2(h0l)}{\sum\limits_{i=1}^{t} Z_i^2 - U_{n_10}\,U_{n_30}\,F^2(000)}, \tag{3a}$$

where Σ' denotes $\sum\limits_{h=-\infty}^{\infty}\ \sum\limits_{l=-\infty}^{\infty}$,

excluding the term with $h = l = 0$. Substituting in (3a) the appropriate U_{nh} from the table and the other quantities mentioned above, we obtain $I'(000) = 0{\cdot}85F^2(000)$, differing from the assumed $I'(000) = F^2(000)$ by 15 per cent; an acceptable error obtained by deliberately choosing rather rough values of $\bar{f}(hkl)$.

Details of this work, including the method of correcting for the effect of small heavy atoms, will be presented elsewhere.

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FRACTURE OF SOLIDS

A CONFERENCE on "The Fracture of Solids" was held by the British Rheologists' Club on October 29. Prof. N. F. Mott, recently elected president of the Club, opened the conference by pointing out that, quite apart from its practical importance, fracture was the most interesting property of solids to the theoreticians because it is the least understood property, no progress having been made beyond the Griffith crack-theory of 1924. It is not known how cracks exist nor what causes them; experimental work has made clear what happens during fracture, but not how it occurs.

Dr. C. F. Tipper then presented a paper describing some beautiful experimental work on the subject of fracture in mild steel. She divided fracture into three types: the first corresponds to a parting along a shear plane; the second along two intersecting planes, giving a wedge-shaped fracture; and the third along a plane quite different from the shear plane, often at right angles to the principal tensile stress. Iron and mild steel show all three types of fracture, and it is possible to have all in the same test-piece, even in adjacent crystals. The amount of energy absorbed in fracture depends on how much of each type goes to make up the total fracture. The third type, which is generally brittle, can always be traced back to a notch, and so in laboratory experiments a notch is inserted deliberately. The metal at the base of the notch can be regarded as a tensile specimen of very short gauge-length eccentrically loaded, and the natural crack is thus started at 90° to the direction of loading. In a very ductile material the crack eventually turns to 45°, and in a brittle material its mean path remains perpendicular to the direction of loading.

Dr. Tipper showed the importance of inclusions in the metal, separation occurring around such inclusions at an early stage in the deformation and forming a pattern of holes near the actual fracture. This separation divides the material into a bundle of independent test-pieces. Inclusions can also stop a fracture when they lie at right angles to the direction of propagation, as they then relieve the stress. Fracture is thus very strongly structure-sensitive. The main conclusion of this work is that fracture begins piecemeal at different places in the material, a fact confirmed by the work of Bridgman, in which a high hydrostatic pressure is found to increase ductility. In the processes of rolling and wire drawing, cracks are not allowed to open, and this is why such large strains are possible without fracture.

Prof. H. Moore then spoke on the fracture of glass. He pointed out that the phenomena of fracture should be explainable in terms of structure, but that a theory of structure could not be based on a study of fracture alone, as had been attempted by some workers. Vitreous silica consists of SiO_2 tetrahedra linked by the oxygens at the corners, each tetrahedron having four linkages at 120° to each other. In silicate glasses the introduction of an alkali such as sodium oxide breaks these linkages, but divalent oxides, such as lime, can provide bridges between tetrahedra which have become temporarily separated. On the molecular scale the structure is irregular, but on any larger scale it is isotropic, giving rise to the familiar conchoidal type of fracture. The structure has no slip planes, and if strained so that one linkage is broken, the other neighbouring linkages, inclined at 120° to the broken link, are also disrupted. Glass has therefore no ductility, its yield strength being equal to its breaking strength.

As with metals, the strength calculated from the structure is many thousand times greater than the observed strength. Fine freshly drawn glass fibres are, however, many hundred times stronger than massive glass; but the strength diminishes extremely rapidly in moist air. The weakness of glass is in its surface, and can be accounted for by the Griffith surface-flaw theory in combination with the effects produced by adsorbed moisture. Moisture rapidly alters the surface layers and can, in fact, cause the whole of the skin to peel off. Under continuous steady loading in moist air, glass is weaker than under momentary loading, due to progressive deterioration of the side-surfaces of the flaws opened by the deformation. This is not a fatigue effect similar to the fatigue effects in metals; under continually reversed loading, glass shows no sign of fatigue because its structure is not affected by the strain reversals.

Mr. H. Warburton Hall then spoke of the fracture of plastics. The understanding of fracture is likely to be easier in the case of the thermo-plastic types than in the case of the more heterogeneous thermosetting plastics. A large amount of experimental data on the mechanical behaviour of the former have been obtained, including investigations into the dependence of tensile strength on such fundamental properties as molecular weight, molecular weight distribution, chemical structure of the polymer, crystallinity, molecular orientation, time of stressing, etc. Haward found that the time to fail of cellulose acetate under constant stress was independent of any rest or deformation-recovery periods allowed during the test, and depended only on the total time under stress; thus in this case all stressing does irreparable damage.

Mr. Hall described investigations on methyl methacrylate at the Royal Aircraft Establishment which had confirmed that tensile stress combined with solvent vapour absorption caused crazing, and that crazing consists of fractures in the surface of the material. The fractures are local tensile failures which under continued stressing lead to bulk failure. There are, however, two main conditions of the material which influence its tendency to craze. (1) Condition direct from the casting process: the material then contains residual solvent (namely, monomer) and elastic strains. If either the solvent content or the condition of elastic strain is increased, crazing will result. In this case solvent vapour causes random pattern crazing. (2) Heat-treated condition: in this case the residual monomer is fully polymerized, the elastic strains are eliminated and *both* solvent vapour and tensile stress are needed to cause crazing. The craze lines, however, are now always perpendicular to the direction of the tensile stress.

A large number of liquids have been investigated, and all those which swell or dissolve the polymer tend to cause crazing.

Finally, Mr. Hall mentioned that the detailed investigations by E. W. Russell on the solvent-vapour absorption characteristics of methyl methacrylate had indicated the possible mechanism of crazing. His results show that films of the polymer stretched at high temperatures and then cooled to normal temperatures while stretched, absorb vapour more rapidly than films not so stretched. It is likely, therefore, that crazing is due to non-uniform vapour absorption which causes stress relaxation at one point, resulting in stress concentration at others, until local rupture takes place, which appears as crazing.

Dr. E. Orowan spoke on the theory of fracture, pointing out that the Griffith crack-propagation theory gave a very good account of fracture phenomena in glasses. According to the Griffith formula, the strength should be proportional to the square root of the surface energy; according to experiments by Obreimow and himself, the surface energy of mica is about twelve times higher in vacuum than in air, and, if this ratio is assumed for glasses, the strength in vacuum should be about $\sqrt{12}$ (or 3·5) times higher than the strength in air. The same ratio should exist between the fracture stresses for very short and very long durations of the test, because the air cannot penetrate to the tip of the crack in the first case; moreover, there should be no difference between long-time strength and short-time strength if the experiment is carried out in vacuum. All these conclusions have been confirmed experimentally. Dr. Orowan pointed out the geometrical meaning of the two-dimensional fracture criterion put forward by Griffith in 1924. If the two principal stresses P and Q are plotted as ordinates, the criterion of fracture is represented in the plane of P—Q by a curve consisting of a parabola, with vertex at the origin and axes directed at 45° into the negative quadrant, and also of the vertical and horizontal tangents to this parabola. He found that this fracture criterion agrees very well with recent experiments of P. W. Bridgman on the fracture of brittle materials under hydrostatic pressures.

In the discussion Dr. R. N. Haward pointed out that over a time-range of $10^7 : 1$, Preston had found that the relation between log T and $1/S$ (S is breaking strength) is linear, and he doubted whether this would bend over just at the limits which were set by the experimental conditions to give Dr. Orowan's factor of 3·5.

Mr. R. L. Brown spoke on the fracture of coal, where one is interested in the size distribution of the fragmented pieces and also the variation of strength of these pieces with size. He showed that, when the size distribution of broken coal deviates from the natural distribution, some of the particles can be relatively weak, so that further rough handling of the consignment of coal tends to bring them back to the natural size-distribution. This theoretical investigation is confirmed by experimental evidence on one coal. Mr. Brown pointed out that, in the case of coal, one had to think of millions of particles, and it was not possible to consider an individual test-specimen; accordingly, the strength measurements were made by a shatter test, in which the coal was dropped several feet on to an iron plate, and the strength calculated from the resulting degradation.

Dr. W. W. Barkas spoke on the fracture of wood, the oldest structural material. Under tension, wood fractures by the oxygen groups, and the tensile strength accordingly only goes down by 25 per cent when the wood is wet. On the other hand, under compression, wood fractures by shear on the hydroxyl groups, and the compression strength goes down very much more when the wood is wet. In the manufacture of bent-wood furniture, the bending is therefore by kinking on the inside, the outside remaining unbroken. The work due to fracture is almost independent of the moisture content.

M. W. THRING

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

IN discussing recent proposals for an Institute of Biology in Great Britain (see *Nature*, December 4, p. 878), reference was made to the recent establishment and activities of the American Institute of Biological Sciences (A.I.B.S.).

During the Second World War, American biologists became acutely conscious of the fact that the importance of biology and the value of the contributions which biologists were making toward the war effort were little understood by the general public and by Government circles in the United States. As a result of this feeling, a movement developed which finally culminated in the establishment of the American Institute of Biological Sciences. After an informal meeting of a few biologists in Cleveland during September 1944 under the leadership of Prof. E. G. Butler, of Princeton University, an open meeting was called in St. Louis in March 1946 under the sponsorship of the Union of American Biological Societies, the American Biological Society, and the American Society of Naturalists. Dr. Detlev W. Bronk put forward the idea of a biological institute, and those present urged that the informal group continue its deliberations. As a result, this group presented plans to the Division of Biology and Agriculture of the National Research Council for the formation of an Institute. An advisory committee, with Prof. H. B. Steinbach as executive secretary, drew up a proposed constitution and by-laws. An organising board, consisting of one representative from each biological society affiliated with the Division of Biology and Agriculture of the National Research Council, met on April 11, 1947, adopted the constitution and by-laws, and presented the plans to the several societies for ratification. It was agreed that when ten societies had given their adherence to the Institute it would be formally organised. This was accomplished by January 1948, and on February 20, 1948, representatives of the adhering societies met in Washington and formally constituted the American Institute of Biological Sciences.

The purpose of the Institute as expressed in its constitution is "the advancement of the biological sciences and their applications to human welfare. To serve these purposes, the Institute will, among other things, assist societies and other organisations in such matters of common concern as can be dealt with most effectively by united action; co-operate with local, national and international organisations concerned with the biological sciences; promote unity and effectiveness of effort among all those who are devoting themselves to the biological sciences and their applications by research, teaching, or by study; and foster the relations of the biological sciences to other sciences, to the arts and industries, and to the public good."

The Institute is set up within the framework of the National Research Council. Several categories of membership are provided: (1) member organisations—societies and other non-profit organisations having a national field of operation in the biological sciences; (2) individual members; (3) affiliates—societies wishing to support the Institute in a less active way than through full membership; (4) associates—commercial or other organisations. The Institute is managed by a governing board, consisting of one representative of each member organisation and four representatives of the National Research Council, with a smaller executive committee. The executive officer is designated as the executive secretary. Member societies make annual grants to the Institute in proportion to their membership. Affiliated societies pay 100 dollars or more, and associates pay a minimum of 200 dollars per year. Headquarters of the Institute are in the National Academy of Sciences, National Research Council Building, 2101 Constitution Avenue, Washington, D.C. The chairman of the board of governors is Dr. Ralph E. Cleland; the vice-chairman, Dr. E. G. Butler; and the executive secretary, Dr. Milton O. Lee. Up to the present, fifteen societies have become full members and two societies affiliated members; they are as follow: American Association of Anatomists, American Physiological Society, American Phytopathological Society, American Society for Horticultural Science, American Society of Ichthyologists and Herpetologists, American Society of Parasitologists, American Society of Plant Physiologists, American Society of Zoologists, Botanical Society of America, Ecological Society of America, Genetics Society of America, Mycological Society of America, Poultry Science Association, Society for the Study of Development and Growth, Society of American Bacteriologists, American Society of Mammalogists, Society of American Foresters.

Since its creation in February 1948, the Institute has undertaken a number of projects. It organised the annual meetings for eleven biological societies which met in Washington during September 1948. It appointed a Committee on Selective Service, which became the Panel of Biology of a committee advisory to General Hershey, director of selective service. This panel has worked with similar panels in other fields to develop a comprehensive plan for selective service which will utilize scientific and technical man-power to the greatest advantage. Recognition and utilization of this Committee marks a definite step forward for biology, this being the first time that biology has been officially recognized in connexion with man-power problems in the United States. The Institute has established a roster of individual biologists who are members of the constituent societies; more than 10,000 individuals are at present listed. A study of publication costs and of possible ways of aiding biological publication is now going on. The Institute is endeavouring to secure increased financial assistance for the American Type Culture Collection, and is developing a plan for a broader and more secure foundation of support for this essential organisation. The publication of a hand-book of biological data is being initiated. The Institute is working with the American Association for the Advancement of Science in the organisation of the meetings of the various biological societies which are to be held in New York during December 1949, and is studying the whole question as to times and meeting-places for future joint meetings of biological societies. A number of other projects are planned for the immediate future and will be undertaken as soon as possible.

The American Institute of Biological Sciences has thus been able to make a distinct contribution to the progress of biology in the few months of its existence.

TETRAETHYL PYROPHOSPHATE AS AN INSECTICIDE

THE shortage of nicotine for use as an insecticide has stimulated the search for suitable substitutes. One of the organic phosphorus insecticides called hexaethyltetraphosphate (H.E.T.P.) seemed to fulfil many of the requirements; but more recent research has indicated that tetraethyl pyrophosphate (T.E.P.P.) is responsible for at least the major part of the insecticidal activity of hexaethyltetraphosphate, and that an insecticide containing a high percentage of this material was desirable. Messrs. Albright and Wilson have now available an insecticide containing 40 per cent tetraethyl pyrophosphate as compared with the 20 per cent contained in so-called hexaethyltetraphosphate. They are issuing a brochure describing the properties of this material and its use as an insecticide.

Tetraethyl pyrophosphate is a mobile liquid, miscible with water and most common organic solvents; it is not, however, freely miscible with petroleum ether or other paraffin hydrocarbons. In the absence of moisture it is a stable compound, but it hydrolyses rapidly in the presence of water. It is hygroscopic. It is said to be compatible with a variety of insecticides and fungicides; but it should not be used with alkaline materials. It may be applied as a spray or as an aerosol. In the concentrations used it exhibits very little phytotoxicity. It lacks the fumigant effect of nicotine. Tetraethyl pyrophosphate is very toxic to warm-blooded animals, and the concentrates must be handled with great care. The products of hydrolysis are said to be harmless, and it would appear that no toxic residues should be present forty-eight hours after spraying, although it seems desirable that a safety margin should be allowed.

Its chief use in practice would appear to be for the control of aphids and thrips, although it may be found useful for other pests; for example, it appears to be effective against the active stages of red spider, although it seems to have little or no ovicidal effect. Another organic phosphorus compound, 0.0.-diethyl 0.-*p*-nitrophenyl thiophosphate, is probably at least as effective an insecticide as tetraethyl pyrophosphate against most of the insect species on which it has been tested, and much more effective against some species. It also acts as an ovicide. This compound, therefore, may prove a serious competitor with tetraethyl pyrophosphate, but it has the disadvantage that, not only is it toxic to warm-blooded animals, but also it is a stable compound and therefore liable to leave dangerous residues. In some circumstances, therefore, tetraethyl pyrophosphate may be the preferable insecticide.

C. POTTER

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"Explorations in Western Mexico" (Kodachrome films with commentary by Dr. Telford H. Work).

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH MIDLAND CENTRE (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6 p.m.—Mr. H. E. Dance: "Visual Methods in Engineering Teaching". (To be repeated on Thursday, March 17, at Savoy Place, Victoria Embankment, London, W.C.2, at 5.30 p.m., and on Tuesday, April 5, at the Engineers' Club, Albert Square, Manchester, at 6.15 p.m.)

SOCIETY OF CHEMICAL INDUSTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. T. Vickerstaff: "The Physical Chemistry of Dyeing".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (joint meeting with the **WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY**, at Woolwich Polytechnic, Woolwich, London, S.E.18), at 7.30 p.m.—Dr. G. E. Turfitt: "Science in Criminal Investigations".

Tuesday, March 8

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Annual General Meeting; at 1.10 p.m.—Colonel B. Ungerson: "Some Deficiencies in Present-day Industrial Psychology".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Daryll Forde: "The Human Factor behind Food from Africa".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. W. C. Osman Hill: "Man's Relation to the Apes".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. Leyland: "The Application of Vacuum to Industrial Chemical Processes"; Mr. G. Arrowsmith: "The Production of Vacuum for Industrial Chemical Processes".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. G. Delépine (Lille): "Comparative Stratigraphy of the Carboniferous Marine Formations in N.W. Europe and Mediterranean Area". (Special University Lectures.)* (Further Lecture on March 10.)

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Dr. J. W. Jackson: "Domesticated Animals from Archæological Sites".*

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. W. Harrison: "The Colour of Fluorescent Lamps".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Harry Vickers: "South German Cities".

INSTITUTION OF THE RUBBER INDUSTRY, BURTON-ON-TRENT SECTION (at the Education Offices, Guild Street, Burton-on-Trent), at 7 p.m.—Mr. H. Willshaw: "Machinery Requirements for the Rubber Industry".

Royal Institute of Chemistry, London and S.E. Counties Section (joint meeting with the **Welwyn Garden City Scientists' Club**, at The Cherry Tree, Welwyn Garden City), at 8 p.m.—Dr. A. Albert: "Drug-Action, Ions and Neutral Molecules".

Institution of Electrical Engineers, Cambridge Radio Group (at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Prof. D. R. Hartree: "Electronic Calculating Machines".

Wednesday, March 9

Institute of Fuel, North-Western Section (joint meeting with the **National Smoke Abatement Society**, at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. P. D. Kirkman: "The Efficient Use of Fuel".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir John Forsdyke: "The Functions of a National Museum" (Trueman Wood Lecture). (Further Lectures in the series on Museums will be given on March 23 (Mr. Trenchard Cox: "The Provincial Museum"), March 30 (Mr. Edgar Kaufmann: "Museums and Industrial Design"), April 6 (Mr. A. S. Edwards: "The Local Museum"), April 27 (Dr. Iorwerth C. Peate: "The Folk Museum"), May 11 (Mr. Elias Svedberg: "Museum Display"), and on May 25 (Dr. D. A. Allan: "Museums and Education").)

Linnean Society of London (at the British Museum (Natural History), Cromwell Road, London, S.W.7), at 3 p.m.—Demonstration: "Zoological Taxonomy after 1758".

Society of Public Analysts and other Analytical Chemists (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3.30 p.m.—Annual General Meeting.

Society of Chemical Industry, Microbiological Panel of the **Food Group** (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Annual General Meeting; at 6.30 p.m.—Dr. E. Windle Taylor: "Microbiological Problems in the Production of Pure Water".

Scientific Film Association (in the Lecture Theatre, Wellcome Foundation, 183 Euston Road, London, N.W.1), at 7 p.m.—Miss F. Anthony: "The Organisation of a Research Film Unit".

Institution of the Rubber Industry, Southern Section (at the Polygon Hotel, Southampton), at 7.15 p.m.—Mr. H. J. Lanning: "Neoprene".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.30 p.m.—Mr. G. A. R. Foster: "Some Automatic Testing Instruments for the Measurement of the Regularity of Cotton Yarns and Rovings".

Thursday, March 10

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Charles Harington, F.R.S.: "National Institute for Medical Research".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. C. E. Dent: "The Development and Application of Paper Chromatography".* (Further Lecture on March 17.)

Linnean Society of London (joint meeting with the **Systematics Association**, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Cytology as a Factor in Taxonomy" (to be opened by Dr. W. B. Turrill).

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. G. A. Barnard: "Statistical Inference".

Illuminating Engineering Society, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. E. Harper and Mr. H. P. Walker: "Acrylic Plastics in Lighting".

Institute of Welding (joint meeting with the **Institution of Structural Engineers**, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. J. T. Phillips and Mr. F. J. Daniels: "Welded Steel Framed Buildings".

Society of Chemical Industry (joint meeting of the **Nottingham Section** and the **Fine Chemicals Group**, at the Gas Company's Show Room, Parliament Street, Nottingham), at 6.30 p.m.—Mr. J. C. McGowan and Mr. J. F. Grove: "Some Applications of Physical Chemistry to the Study of certain Biologically Active Compounds".

British Association of Chemists (at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Dr. Joseph Needham, F.R.S.: "The Work of U.N.E.S.C.O.".*

University of London (at Wye College, Wye, Kent).—Sir John Russell, F.R.S.: "Agricultural Research in the 20th Century" (Fellowship Lecture).*

Friday, March 11

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Physical Society (in the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Scientific Papers. (Members of the Colour Group are invited.)

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Discussion on "Polarographic Analysis".

University of London (in the Geology Lecture Theatre, Royal School of Mines, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. F. T. Brooks: "The Contribution of the Plant Pathologist to Horticulture".*

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Application of Flux Meters to Experiments on Electric Machines" (to be opened by Prof. E. B. Moullin).

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. W. L. Gawn: "Cavitation of Screw Propellers".

Institution of Structural Engineers, Lancashire and Cheshire Branch (at the College of Technology, Manchester), at 7 p.m.—Mr. G. R. Hinks: "Building the Central Library and Town Hall Extensions, Manchester".

Saturday, March 12

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. J. C. Wood-Mallock: "Solvent Extraction as a Unit Process".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Agricultural Economist in the Department of Agriculture—The Registrar, The University, Leeds 2 (March 10).

Senior Scientific Officer (with a degree in science with first-class honours in botany) and a **Senior Experimental Officer** (with at least the H.S.C. in a science subject or equivalent qualification and a good knowledge of crops and crop husbandry), at the Department of Agriculture for Scotland Seed Testing and Plant Registration Station at East Craigs, Corstorphine, Edinburgh—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2434 (March 10).

Assistant Experimental Officers (3, temporary), Food Infestation Control, Department of Agriculture for Scotland—The Secretary, Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.536/48 (March 10).

Deputy Statistical Officer in the Statistical Section of the Town Clerk's Department—The Town Clerk, Room 30B, Council House, Birmingham 1, endorsed 'Deputy Statistical Officer' (March 11).

Lecturer in Chemical Engineering—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (March 12).

Research Manager—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx. (March 12).

Lecturer (Grade III) **in Chemistry**, with special interest in physical and inorganic chemistry—The Registrar, Queen Mary College, Mile End Road, London, E.1 (March 14).

Junior Assistant Physicist in the Physics Department—The Secretary, Bristol Royal Hospital, General Hospital Branch, Guinea Street, Bristol 1 (March 15).

Geological and Topographical Draughtsmen in the Department of the Geological Survey of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (March 15).

Lecturers (2, Grade II) **in Mining**—The Secretary, The University, Birmingham 3 (March 19).

Readership in Theoretical Physics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

Robert Blair Fellowships in Applied Science and Technology—The Education Officer (H.1/2), County Hall, Westminster Bridge, London, S.E.1 (April 1).

Visiting Professor of Plant Physiology at the Faculty of Science, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (April 15).

Senior Technician with histological training for laboratory principally engaged in endocrinological research—Professor of Anatomy, Medical School, Edgbaston, Birmingham 15.

Laboratory Technicians—The Regional Blood Transfusion Officer, Bridle Path, York Road, Seacroft, Leeds.

Senior Technician in the Department of Materia Medica—The Administrative Officer, Medical School, Dundee.

Laboratory Assistant to help in sorting and mounting entomological material—The Secretary, Department of Entomology and Parasitology, School of Tropical Medicine, Liverpool 1.

Physicist or **Engineer** to develop various special components of the cyclotron, and a **Vacuum Engineer**—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12, endorsed 'Cyclotron'.

Experimental Officers (2) to assist in studies of Bee behaviour—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Research Physicist for fundamental research on Atmospheric Physics—Dr. G. B. B. M. Sutherland, Pembroke College, Cambridge.

Technician (Grade III) as second Lecture Theatre Assistant in the Department of Physics (Ref. Physics/2), and a **Technician** (Grade IV) in the Department of Geology (Ref. Geology/2)—The Secretary, University College, Gower Street, London, W.C.1, quoting the appropriate Ref.

Entomologists (2) in the Research Division of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Agricultural Entomologist'.

Inspector (Plant Protection) **in the Research Division** of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Plant Protection'.

Lecturer or Assistant Lecturer in Mathematics—The Registrar, University College, Exeter.

Surveyors (experienced and qualified) in the Survey Department of Hong Kong, Malaya, Nigeria, the Gold Coast and Tanganyika—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Physicist, a **Chemist**, and an **Engineer**, for a new laboratory at Galashiels—The Secretary, Wool Industries Research Association, Torridon, Leeds 6.

Field Zoologist in the Veterinary Department, Kenya, for Tsetse Fly survey and control—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in General Science with particular application to foodstuffs, and a **Lecturer in Foodstuffs** with experience in nutrition and microbiology—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

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GOVERNMENT INFORMATION SERVICES

THE Central Office of Information was established on April 1, 1946, to take over a wide but closely specified range of duties from the Ministry of Information. Its first annual report* is of particular interest as giving the first available description of the general organisation of the Government information services and of the responsibilities and activities of the Central Office. The report emphasizes that the Central Office of Information is not a policy department, and that the responsibility for information and publicity policy in Britain always rests with the ministerial department covering the field into which the subject falls. Primarily the Office is a professional and technical service agency for nearly forty departments, being responsible for producing information or publicity material required by them, and being treated as the expert in presentation. It performs various other services which do not entail the production of material; but any general influence it exerts in the nature and efficiency of information services derives from its relative size and central function, rather than from its constitutional powers. Apart from the fact that the Central Office itself employs no staff overseas, a similar relation exists between the Central Office and the Information Departments of the Overseas Departments and of the Board of Trade.

In home affairs, material produced by the Central Office to add to public knowledge and understanding of public affairs has been largely directed towards increasing public understanding of the national economic situation. Here the Central Office is clearly fulfilling a recognized need for Government publicity. The Government has a duty to explain its policy and legislation; moreover, publicity is required for persuasive purposes in fields of safety and health and where coercive legislation is impossible. Nevertheless, it may fairly be urged that some of the Government action campaigns such as those described in this report have been weak substitutes for a courageous policy. There is a further educational function discharged by the Central Office in the way of providing technical and specialized information to assist sections of the public in their work and also in recording and reflecting significant aspects of the national life and achievement. Here it may be noted with interest that the Central Office has arranged a number of exhibits and displays for the Department of Industrial and Scientific Research, including one in connexion with the centenary of the Chemical Society. In such a matter the Central Office is in special danger of undertaking with doubtful efficiency what independent publicity experts could do better, and the Panel on Technical Information Services may well have under review some aspects of the work of the Central Office of Information.

That is, indeed, one of the main criticisms that can be made of the work of the Central Office of Information. The report could well have included much more detailed information about its own work and the specific functions which occupy its staff of 1,698 people in such varied fields as the distribution of news, the publication of books and periodicals, the production of films, and the conduct of social surveys, tourist and photographic lecture agencies, exhibitions, and Press and poster advertising, as well as the provision of what is described as reference services. The Central Office can, indeed, prevent campaigns from overlapping and can advise departments on the use of publicity methods; but, as the report demonstrates very plainly, it possesses no authority to ask the crucial question whether any particular activity is really worth while, and to counsel a department accordingly to curtail or abandon a projected programme.

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* Annual Report of the Central Office of Information for the Year 1947–48. (Cmd. 7567.) Pp. 56. (London: H.M. Stationery Office, 1947.) 1s. net.

This, however, is the critical question. As regards the necessity and value in general of the activities outlined in the report there can be little doubt. Such work must be undertaken by the Government of a modern State which seeks to command public understanding and support for its policies; and variations in the standard of performance of particular duties by the Central Office of Information are comparatively unimportant. The wisdom or expediency of particular projects is altogether another matter, and while the report reveals that the Central Office has not the status to raise such a question, the contents of the report alone illustrate how imperatively the public interest demands that such questions should be asked and answered plainly.

Unless the work of the Central Office of Information is to be wasted in futilities, its activities must be realistic and limited to projects for which a convincing statement of their public value can be made. The Government has already instituted an inquiry into the methods and organisation of information services. There is also needed, however, a careful and unceasing scrutiny of particular projects, such as the Select Committee on Estimates is accustomed to give, and which the Select Committee on National Expenditure gave to the Wartime Social Survey in a report published in February 1942. The present report includes a brief section on the Social Survey, which, however, adds little to the account published in *Nature* last year (161, 573; 1948) beyond listing examples of the collection of statistical data on the survey of sickness and on retail trade indexes carried out for the statistical divisions of departments and also examples of special problems into which research has been conducted. The latter comprise a survey of the composition of population and types of household in connexion with post-war housing in Glasgow; an estimate of the demand for war medals and decorations; an inquiry in Willesden in relation to the development of new towns; an inquiry as to the numbers of people likely to benefit from and use hearing aids under the new health scheme; and an inquiry into the social factors involved in the employment of women. In all, surveys were made during the year for ten departments. The work of this section again demonstrates that, in the absence of an authority at a higher level, there can be no assurance that a technical agency—such as the Central Office of Information essentially is—will be wisely used, and departmental campaigns planned with proper foresight from the point of view of the expenditure of public money or the most appropriate means of achieving the objective. Below Cabinet level, there appears to be nothing apart from critical examination by the Select Committee on Estimates to prevent the continuing wastage of public money on schemes which may originate from departmental vacillation and failure to evolve policy properly co-ordinated at Cabinet level with the requirements and policies of other departments.

The weaknesses of the Central Office of Information are, by and large, not of its own making, and there is a danger that criticism of them may be directed against the Central Office rather than against the departments and ministers primarily responsible. It is not so much the quality of the work but its quantity that is in question, and whether the right objectives are being achieved. It would be disastrous if in the present economic situation there were any interruption of the means by which the public are informed of the affairs and the purpose and implications of Government policy and action. But efforts to secure necessary exhortation and publicity cannot be multiplied indefinitely as a substitute for resolute leadership and for administrative action which really grapples with difficulties. Further, such efforts must never be allowed to obscure the vital fact that only through some form of central Government information services, both directly and with the co-operation of the Press and other agencies, can public support and understanding be secured for the measures, often unpalatable, necessary for economic recovery and for social advance.

BIOCHEMISTRY OF BEHAVIOUR

Hormones and Behavior

A Survey of Interrelationships between Endocrine Secretions and Patterns of Overt Response. By Prof. Frank A. Beach. Pp. xv+368. (New York: Paul B. Hoeber, Inc.; London: Hamish Hamilton, Ltd., 1948.) 6.50 dollars.

IN this book Prof. F. A. Beach reviews the literature on the "interrelationships between endocrine secretions and patterns of overt response" in vertebrates, the purpose of the book being "not the exposition of a thesis but the supplying of a body of facts and references". These are classified under the following chapter headings: courtship and mating; reversal or bisexuality of mating behaviour; oviposition, parturition and parental behaviour; migration; generalized aggression; social dominance or submission, and territory defence; emotion; conditioning and other types of learning; general locomotor activity; homeostasis, metabolism, metamorphosis and moulting; morphologic structures employed in specific behaviour patterns; the role of nervous stimulation; developmental aspects; major sources of variability; and interpretations of hormonal effects. The bias of treatment in favour of sexual behaviour reflects, as the author correctly points out, the tendency of experimentalists to concentrate on those phenomena in which behavioural responses to hormonal stimulation are most evident and most specific.

Prof. Beach's aim is to review the results of only the more important studies, and the uneven balance of the chapters reflects his own research interests, as do the rare statements of personal opinion in certain chapters. Usually no critical evaluations are given of the reports that are summarized, and some subjects receive very little notice. For example, eight pages only are given to the literature concerning the hormonal control of metabolism and homeostasis. The discussion of aggression and social behaviour is narrow in scope, and the chapter on emotion, while revealing the paucity of information on this subject, is scarcely a good summary of the work that is available. The sections on human behaviour with which some chapters end are also very limited. Those topics (for example, bisexuality of mating behaviour; the role of nervous stimulation; interpretations of hormonal effects) to which Prof. Beach has himself contributed, are not surprisingly the more interesting and useful, and the relevant chapters lead to certain general conclusions. For example, as the author points out, no behavioural response yet investigated depends upon one and only one hormone. Again, no hormone produces one and only one effect upon an organism. Furthermore, hormonal control of a complete behaviour-pattern appears to be mediated by several intervening mechanisms rather than a single critical one, while different behaviour patterns vary in their degree of dependence upon endocrine products, and this dependence also varies from species to species for a similar behavioural reaction.

Prof. Beach's concentration on recent work, and in particular on papers published in American experimental journals, often leads him implicitly to attribute credit for observations to workers who were by no means the first to make them. More important, it often obscures the major interest of the fields to which the observations belong, by imposing too much of the particular on the general. "The first complete survey of to-day's knowledge", as its jacket describes the book, should at least attempt to present that knowledge with a sense of proportion and perspective; and it should show how later work has derived from original studies and generalizations, and how knowledge has progressed along certain definite lines. The fact that Prof. Beach's book does not do this detracts greatly from its intellectual value. In his introduction the author suggests that books develop in one of two ways. "The first type grows like a living organism, starting with a central idea and proceeding along a course of differentiation and individuation so that the final result represents a well organized whole." In contrast, the second type (in which category Prof. Beach places his book) "grows by accretion, like a pearl, or, to use a less flattering simile, like a snowball rolling downhill". If indeed there are two such ways of writing a book, it is difficult to understand why Prof. Beach chose the second, although it is easy enough to see that the faults of his book mainly derive from it. One may hope that the other way is selected for the second book he may write, and that he does not rest satisfied with the fact that his present one is a useful review and source book of references in the borderland between endocrinology and comparative psychology.

THE ART OF PHYTOTHERAPY

Le livre des plantes médicinales et vénéneuses de France

Par Dr. P. Fournier. Tome 1: Abricot à Coloquinte. (Encyclopédie biologique, Tome 25.) Pp. lxxviii + 448. (Paris: Paul Lechevalier, 1947.) 800 francs.

During the past century, the active principles of many medicinal plants have been isolated and identified. This has had the advantage of substituting substances of known composition for somewhat indefinite mixtures, with a corresponding gain in accuracy of dosage and consistency of results. It has sometimes happened that the purified substance has not replicated all the known or suspected effects of the crude drug; and this is scarcely to be wondered at, since physiologically active substances like the alkaloids tend to be produced in groups of related compounds rather than by themselves. Members of a group, although chemically similar, may have noticeably different physiological effects. For these reasons modern pharmacopœias still include numerous galenicals side by side with plant extracts, pure 'chemicals' of plant origin, and others that have originated in the laboratory.

One would have supposed that it could only be a matter of secondary importance to a practising medical man whence an effective drug came; but it seems there is a school of medical thought that sees special virtue in a vegetable drug because it is 'organised' and 'natural'. It is from such a point of view that this book is written; but, in spite of its somewhat formidable proportions, it is intended to be a popular work. The Abbé Fournier is a botanist and writes about medicinal plants for a wide public, not about *materia medica* for medical men only. He is a great admirer of the modern use of galenicals, and follows those who see in it a branch of medicine worthy of being dignified with the special name of phytotherapy. The first requisite of such a system, he says, is to know one's plants accurately. They are numerous, often difficult to distinguish and are referred to by names which make confusion easy. He deplores, above all, modern ignorance of field botany, of which, formerly, every educated person had at least a smattering. The author has therefore set himself the task of describing the medicinal plants of his country to botanical laymen, whether they be medical practitioners or men in the street. For purposes of identification he has reduced as much as possible the use of technical taxonomic terms, and has provided numerous effective line drawings. He goes so far as to say that even a middling figure is a better aid to recognition than the best description. He presumably has the untrained layman in mind, and it is interesting to see with what success he uses this dangerous tool. He does not try it too high. The plant descriptions are prefaced by a dichotomous key of orthodox pattern, headed by the remark that it is quicker in the long run to use the key than to riffle over the pages hunting for a likely picture. Quicker and surer, no doubt, though unfortunately not so amusing.

M. Fournier is a man of letters as well as science, and his descriptions are often felicitous, as when he says of aconites: "Qui a regardé d'un peu près leur fleur, n'en oublie plus l'aspect: quasi le profil d'une Minerve casquée . . . Quant aux pétales, les découvrir est toute une affaire."

As the completed work is to cover 1,500 species, it is evident that it goes far beyond the bounds of official medicine. The latitude taken allows the author to guide his readers through many entertaining by-ways of phytotherapeutic knowledge. It allows him to bring in the successful practitioner of Lyons who, having built himself a house, inscribed above the door, "Les concombres et les melons M'ont fait bâtir cette maison", and to recall the seventeenth-century executioner who, being of a tender heart, was unable to perform his duties until he had chewed a little catmint, "thanks to which, he was instantly seized with fury" and thirsted for blood.

Properties, methods of use and, where necessary as with garlic, drawbacks are also described at length. Anyone interested in the lore of medicinal plants cannot fail to derive both pleasure and profit from these pages, whether he is prepared to subscribe to their general background or prefers to leave it where it belongs.

W. O. James

'OPEN SYSTEMS' IN PHYSICS AND BIOLOGY

Étude thermodynamique des phénomènes irréversibles

Par I. Prigogine. Pp. ix+143. (Paris : Libr. Dunod ; Liège : Éditions Desoer, 1947.)

SINCE 1934, the present reviewer has advanced the conception of the organism as an 'open system'. So far, physical chemistry has been concerned almost exclusively with reactions and equilibria in closed systems, while living organisms are open systems, maintaining themselves in a continuous exchange of materials with environment. We have stressed the necessity for an extension of physical chemistry, stated kinetic principles, and demonstrated that the theory of open systems leads to the derivation of fundamental biological characteristics as well as to quantitative laws of biological phenomena[1]. It has also been emphasized that "according to definition, the second law of thermodynamics applies only to closed systems, it does not define the steady state".

Prigogine's work, devoted to the extension and generalization of thermodynamical theory, is of outstanding importance for physics as well as for biology. As the author states, "classical thermodynamics is an admirable, but *fragmentary* doctrine ; this fragmentary character results from the fact that it is applicable only to states of equilibrium in closed systems. *Therefore, it is necessary to establish a broader theory, comprising states of non-equilibrium as well as those of equilibrium.*" Starting, on one hand, from the concept of open systems, on the other, from thermodynamics of irreversible processes, founded by De Donder and the Brussels School and in his own previous work, Prigogine derives the generalized thermodynamics for the whole realm of physical chemistry, including chemical reactions, electrochemistry, polythermic systems, diffusion, thermoelectricity, etc. These considerations lead to the solution of many problems where, as in electrochemistry, osmotic pressure, thermodiffusion, Thomson and Peltier effects, etc., classical theory has proved to be insufficient. We must restrict ourselves to mentioning a few of the most important, and partly revolutionary, consequences. Irreversible processes in open systems cannot be defined by entropy but only by the approach of a minimum entropy production. Entropy may decrease in such systems ; or, in other words, such systems may spontaneously develop towards a state of greater heterogeneity and complexity. The far-reaching significance of this statement is apparent, since it was often considered an essential difference between inanimate and animate Nature that, according to the second law, physical events appear to be directed towards a levelling down of differences and states of maximum disorder, while in organic development and evolution a transition towards states of higher order and differentiation seems to occur. The principle of Le Chatelier applies not only to closed but also to open systems. The consideration of irreversible phenomena leads to the conception of a thermodynamical, as opposed to astronomical, time.

Prigogine's pioneering work is a most important contribution towards new conceptions, the bearing of which on physics as well as on biology can scarcely be estimated. Not since de Vries' and Pfeffer's work on osmosis have essential developments of physical theory been instigated by biological considerations. The new thermodynamics shows that it is necessary not only for biological theory to be based upon physics, but also that biological points of view can open new pathways in physical theory as well.

Ludwig von Bertalanffy

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[1] v. Bertalanffy, L., *Naturwiss.*, **28** 522 (1940) ; "Theoretische Biologie", **2** (Berlin, 1942) ; further work by Burton, Spiegelman and Reiner, Dehlinger and Wertz, Prigogine and Wiame, and others.

PLASTICS ABSTRACTED

The Science of Plastics

A Comprehensive Source Book based on the Original Literature for 1942–1946. Edited by H. Mark and E. S. Proskauer, with the collaboration of P. M. Doty, V. J. Frilette and B. H. Zimm. Vol. 1. Pp. vii+632. (New York and London : Interscience Publishers, Inc., 1948.) 54*s*.

THIS book is rather unique in character and is a result of the rapid expansion of knowledge in one field of science during a period of very considerable transition (1942–46). In effect, it is a bound volume of abstracts. Since 1942 Interscience Publishers have issued a loose-leaf form of abstracts known as *Rubbers, Resins and Plastics* covering both the scientific and, to some extent, the technological aspects of the subject. These abstracts are of particular value to the worker in high polymers generally for two reasons : (*a*) they are much more extensive than those found in any issued form of chemical abstracts and include numerical results in considerable detail ; (*b*) they cover a wider field than is normally found in chemical abstracts, picking out material from journals not normally read or accessible to those interested primarily in this science of high polymers. No doubt the success of these abstracts and the difficulty of obtaining back numbers have prompted the publishers to re-issue them in a much more convenient form. Thus the abstracts have been collected into systematic groups, so that the book takes on the character of a reference or source book of knowledge on these several topics.

The properties and evaluation of plastics claim a third of the volume, and the physical chemistry of high polymers in a state of equilibrium claims another third. The mechanism of polymerization takes up a considerable fraction of the book, and there is finally a section labelled plastics engineering, an omnibus title that includes such diverse topics as plasticizers, laminates and radio-frequency heating. Author and subject indexes conclude the volume.

In view of the origin of the book, it will be seen that this volume is one for the active worker in the subject. The abstracts are concentrated digests of papers with a sufficiency of detail to make it unnecessary in many cases to look up the original literature if only the numerical results are required. The reader has naturally to use his own critical judgment of the value of the work.

The letterpress of the volume has presumably been reproduced photographically from the loose-leaf abstracts; but the reproduction is of a high standard. As the publishers rightly remark, if the abstracts had been reset in type, the price of the book would have been much higher. Such a resetting is not really necessary in a book of this kind. A further volume is promised soon, dealing with specific types of high polymers. These volumes then can take their place with the abstract service of *Rubbers, Resins and Plastics*, starting in 1947.

H. W. MELVILLE

BIRDS OF NANTUCKET

The Birds of Nantucket

By Ludlow Griscom and Edith V. Folger. (New England Bird Studies, 1.) Pp. xi+156+16 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 18*s.* net.

THE island of Nantucket is some thirty miles off the southern coast of the State of Massachusetts, and has an area of about forty-five square miles. Various small islands, such as Tuckernuck and Muskeget, to the north-west are included in the area. The indigenous fauna consists of a few small mammals and some eight birds, so far as can be estimated from old records. The flora is likewise limited, but Scotch firs have been planted and the heather brought with them has become established in places. In sheltered hollows and near the towns there are deciduous trees.

Formerly whaling and fishing vessels were based on the island. In the winter many of the fishermen shot wild fowl for the market, and from 1870 onward sportsmen came from the mainland to shoot. Before long, ducks and wading birds began to decrease seriously in numbers; but now there is little shooting—field-glasses are replacing guns. The island has to-day become a summer resort, and birds of all kinds are increasing in numbers again. In 1870 Brewster estimated that several thousands of common terns nested on the north coast of Nantucket; but four years later this colony was depleted. Plumage hunters are said to have killed 40,000 of these terns in one year. So much for human interference. But in 1890 Brewster computed that the common tern colony on Muskeget numbered 20,000 birds. A few years later these numbers had decreased, and gradually the laughing gulls breeding there increased, so that by 1936 there were 30,000 of them. Then herring gulls also commenced to breed in the same area and by 1946 numbered 2,500, with a corresponding decrease in the laughing gulls and terns.

Owing to the exposed position of Nantucket the shoals and sandbanks around the island are continually shifting, and this seriously affects the feeding grounds of the diving ducks. Little spring migration is seen on the island, though in the autumn considerable numbers of birds pass through. The authors consider that there is a large mortality among passerine birds in the autumn migration. They have observed a warbler start off from the south low over the sea, only to be overwhelmed by a large wave. Others are regularly noted on steamers as far as fifty miles out, and apparently must suffer the same fate. In the systematic list the status of each species is given in a comparative manner, definite counts are recorded where possible, and a point is made of stating what is not known about certain species.

This interesting little work is illustrated with some beautiful photographs by Allan Cruickshank.

N. B. KINNEAR

FISHES AND FISHERIES OF THE GOLD COAST

The Fishes and Fisheries of the Gold Coast

By F. R. Irvine; with Illustrations and an Account of the Fishing Industry, by A. P. Brown, and Classification and Keys for the Identification of the Fishes, by the late J. R. Norman and by E. Trewavas. (Published on behalf of the Government of the Gold Coast.) Pp. xvi+352. (London: Crown Agents for the Colonies, 1947.) 6*s.* net.

THIS valuable book is based on collections originally made by the author for teaching purposes at Achimota College, near Accra. But, as the collection grew, interest in it spread both within and without the Gold Coast, and a more ambitious collection of named duplicates was built up. Most of the identifications were made by the late Mr. J. R. Norman and Miss E. Trewavas, of the British Museum (Natural History), from specimens sent to them there. Dr. F. R. Irvine was fortunate in also enlisting the help of his colleague, Mr. A. P. Brown, art master at the College, whose excellent drawings are a valuable feature of the book. The arrangement is based on a systematic classification provided by Norman, who also prepared artificial keys to the families, genera and species. Both marine and freshwater fishes are included. The provision of vernacular names should prove of much value to future workers in the Gold Coast region.

An important section of the book is devoted to a study of the fishing industry of the Labadi district, near Accra, and this is written by Brown. It is a most valuable contribution and may well be taken as a pattern by anyone making a similar study of native fisheries elsewhere. Another small section of the book is devoted to some of the larger and more important Gold Coast crustacea, most of which are edible and therefore appear on the markets. The descriptions are accompanied by excellent drawings and should make a useful basis for further and more detailed study of these animals in that region. Brief reference is also made to cetaceans, turtles and the African manatee.

It seems a pity that the title, to most people, will not indicate the full scope of the book. Perhaps this can be corrected if another edition is called for—as it almost certainly will be when the West African Colonies become more fully opened up to commercial fishing and research, and more becomes known about the aquatic faunas of that great region.

G. A. STEVEN

Les caféiers du globe

Par Prof. Aug. Chevalier. Fascicule 3 : Systématique des caféiers et faux-caféiers, maladies et insectes nuisibles. (Encyclopédie biologique, Tome 28.) Pp. 357+17 plates. (Paris : Paul Lechevalier, 1947.) 1,000 francs.

FASCICULE 3 of Prof. Aug. Chevalier's monographic work on the genus *Coffea* and allied genera contains a detailed account of the anatomy of some of the vegetative and reproductive parts, the genetics and variations, the geographical distribution, the systematics, and the diseases and pests of the plants concerned. All these matters are dealt with very fully, and a great deal of information is brought together in one volume. In the genus *Coffea* the basic chromosome number is eleven (as it is in the greater part of the Rubiaceæ). Most wild coffees and many cultivated ones have $n = 11$, but most cultivated varieties of *C. arabica* are tetraploid; and triploid, hexaploid, and octoploid variants and hybrids have also been recorded.

The systematic section is a long one, and the treatment accorded to *Coffea* illustrates the taxonomic difficulties met with in a genus composed of wild and cultivated plants. *Coffea* is divided into four main sections; but the subsection *Mozambicoffea* does not appear to be subordinated to any one of them. Within the four sections and the subsection sixty-four species (and one doubtful one) are recognized. Some of the species, for example, *C. canephora* and *C. arabica*, have numerous varieties. Some 'races' and some hybrids are also given binomials. The 'false coffees' described or more briefly indicated in this work are species of the genera *Psilanthus, Psilanthopsis, Lachnastoma, Diplospora, Hypobathrum, Tricalysia, Belonophora, Chapelieria, Lemyrea, Fernelia, Cremaspora, Polysphæria, Plectronia* and *Randia*, together with several other genera that have in the past been associated with *Coffea*.

Insects and fungi are the worst enemies of coffee, particularly of the more valuable cultivated varieties under certain environmental conditions. The coffee rust (*Hemileia vestatrix*) is naturally dealt with at some length.

W. B. TURRILL

Biochemie der Leguminosen und Fouragepflanzen

Von N. N. Iwanoff. Pp. vii+115. (Amsterdam : Dr. W. Junk, 1947.) n.p.

IN 1938, twelve publications appeared in Russian, each containing information collected from the available literature on the biochemistry of one of the following leguminous and fodder plants : peas, beans, soya beans, lentils, clover, sweet-clover, lucerne, lupin, timothy grass, sorghum, common vetch and chick pea. The book under review, which consists mainly of tables, was compiled from the information contained in these twelve publications by the late Prof. N. N. Ivanoff of Leningrad, who unfortunately died before the printing of the book was completed. The 327 tables, with a few explanatory notes, give the chemical composition of the above-mentioned leguminous and fodder plants, each table being accompanied by the relevant reference(s). Nitrogen ('crude protein'), crude fibre, starch and/or other carbohydrates, fat and ash contents are given for all the plants mentioned, and, in addition, for most of them, figures are quoted giving the amino-acid content of the protein(s), the composition of the ash, and analytical data on the fats. Data are also included showing the influence of different growth conditions and plant varieties on the yield and chemical composition of the fodder plants. More specialized information is not contained in this book, although for clover the hydrocyanic acid, and for lupin the alkaloid content are given, and some figures are quoted for carotene and vitamin C content of peas.

The volume, published in German, is a useful collection of tabulated data, otherwise scattered in journals published in different languages; but, although printed in 1947, the book includes no published information available since about 1938. The table of contents indicates the information contained in the tables, but the numbering of the pages in the book does not correspond to that given in this table, and unfortunately the book has no index.

J. T.

The Rh Blood Groups and their Clinical Effects

By Dr. P. L. Mollison, Dr. R. E. Mourant and Dr. R. R. Race. (Medical Research Council Memorandum No. 19.) Pp. 74. (London : H.M. Stationery Office, 1948.) 1*s.* 6*d.*

A QUESTION one is frequently asked is "Where can I read about *Rh* ?" ; but up to date it was difficult to know how to advise the questioner, since he may be a medical practitioner, laboratory worker or a geneticist. The Medical Research Council memorandum fulfils, therefore, a great need. The first part deals with the *Rh* groups, and a description of the various sub-groups and the different *Rh* antibodies is given. The triple-gene theory of R. A. Fisher and the *CDE/cde* nomenclature arising therefrom are explained. This theory has been substantiated by all recent work, and a thorough knowledge of it is essential for a complete understanding of the *Rh* group. The second part details clinical considerations, the importance of *Rh* in blood transfusions, and the diagnosis and treatment of hæmolytic disease of the newly born.

The last section of the memorandum concerns itself with *Rh* testing, and several methods of typing cells and testing sera for antibodies are described. The reader intending to carry out *Rh* testing, however, should not gain a false sense of security from reading this manual, since, in order to obtain consistently accurate results, considerable experience is required ; and one would have liked to have seen expressed a more definite opinion with regard to the value of some of the techniques described and more stress laid on the necessity for controls. This memorandum is the most clear, concise and authoritative exposition of the present state of knowledge so far published, and all who are interested in this subject should read it.

F. STRATTON

Surveying

Instruments and Methods for Surveys of Limited Extent. By Assoc. Prof. Philip Kissam. Pp. xi+384. (New York and London : McGraw-Hill Book Co., Inc., 1947.) 17*s.* 6*d.*

THE author states that this little book has been written to provide a text-book for a short course in surveying for students of all branches of engineering, and that the material presented differs from that normally found in surveying text-books, in that there has been complete re-arrangement and rejection of some subjects usually covered. The scope is that of the requirement of the engineer for surveying, in connexion particularly with the construction and expansion of works, and of the employment of surveying techniques for setting out in shop-practice—

for example, aircraft assembly, or preliminary bridge-assembly.

From this aspect the fundamental principles and details of surveying, as applied to American practice and with American instruments, are carefully and thoroughly described; perhaps here and there with a touch of the obvious. The book would be suitable for use with a general survey course for mechanical, electrical, chemical and aeronautical engineers, who may have to apply elementary surveying; but it is perhaps rather narrow for a first civil engineering course. Nevertheless, the information it contains regarding the use of survey techniques in assembly shops, etc., should be of considerable interest to structural engineers. Only American instruments are illustrated, and many of those described in detail are of types now abandoned in British and West European practice. Thus the theodolite description is limited to four-screw instruments, of which very few remain in use in Great Britain, and no mention is made of modern optical types, which are of the greatest value, not only in field surveying but also for precise setting out in the shops.

The book is well presented, contains a wealth of practical detail, and excellent sketches, and at the end there are some 120 pages of tables providing all the information necessary for computation of the type of surveying described in the book. It should prove of great value to engineers whose surveying is likely to be limited to that carried out in connexion with industrial works and who wish to apply it accordingly. C. A. H.

Standard Valves

Pp. 328. (London: Standard Telephones and Cables, Ltd., 1947.) 15*s*.

THIS is a useful handbook and high-class bound catalogue of valves manufactured by Standard Telephone and Cables, Ltd. Broadcast receiver valves which are products of the firm's Brimar Valve Division are not included. Valves are classified as preferred, current, maintenance and obsolete; only the first two types are covered by the handbook. There is a section on general information, covering, among other items, definitions, recommendations on cooling of valves, valve bases and codings. The technical data sheets include dimensioned sketches, average characteristic curves and numerical operating data. The range is extensive and, in addition to conventional valves, includes cathode ray tubes, cold-cathode relays, velocity-modulated tubes and a double-disk-seal ultra-high-frequency triode. *CV* codes are given where appropriate. Additional loose data-sheets are to be issued later, but no facilities are provided for including these in the handbook.

Education for Professional Responsibility

A Report of the Proceedings of the Inter-Professions Conference on Education for Professional Responsibility held at Buck Hill Falls, Pennsylvania, April 12, 13 and 14, 1948. Pp. x+207. (Pittsburgh, Pa.: Carnegie Press, 1948.) n.p.

BECAUSE it has become increasingly clear that the major problems of professional education are common to all professions, in April 1948 a group of university teachers in faculties of divinity, medicine, law, engineering and business in America met at Buck Hill Falls, Pennsylvania, to discuss experiences derived from their different occupations.

In order to give ample scope for discussion, the conference was deliberately limited in size, and to it was invited only those with declared interest in improving professional education. Three sessions were arranged, the first dealing with the objectives of professional education, the second with the content and methods of professional instruction and the third with humanistic and social education as preparation for professional responsibility and citizenship. Each of these aspects of professional education was considered in turn by a representative of each of the faculties invited to the conference, and all speakers were asked to draw from actual experience for presentation of their views. This made the conference necessarily limited in objective, but also led to some refreshingly practical statements which should be of value to all who are concerned with the direction of higher education.

These statements have now been set down in book form and merit close study. While it is invidious to pick out particular essays, those by R. D. Collins on "Aims of Business Education", Prof. John Romano on "The Physician as a Comprehensive Human Biologist" and Prof. Elliott Dunlap Smith on "The Education of Professional Students for Citizenship" are especially noteworthy. T. H. H.

The Right Way to Keep Dogs

By R. C. G. Hancock. (Right Way Books.) Pp. 111. (London: Rolls House Publishing Co., Ltd., n.d.) 5*s*.

MAJOR R. C. G. HANCOCK, well known to a vast public as the 'radio vet.', has achieved a masterpiece of compression in this little book. Within the space of 111 pages—small pages with large type—he has covered all that the amateur needs to know about keeping a dog. Feeding, housing, training, breeding and showing are all discussed briefly, but adequately. There is an excellent chapter on disease, and the proper use of the medicine cupboard is wisely stressed. He has even found space to deal with the immense question of choosing a dog, and he has not omitted some mention of the dog in relation to the law. Inevitably the first chapter on the natural history of the dog is the least satisfactory, for that is really a little too ambitious for a book of this size. Nevertheless, Major Hancock has concentrated on the most important points, even though they gain a little in importance through isolation. An excellent book which can be thoroughly recommended.

Récits Bara

Par Jacques Faublée. (Université de Paris: Travaux et mémoires de l'Institut d'Ethnologie, Tome 48.) Pp. 537. (Paris: Institut d'Ethnologie, 1947.) 700 francs.

THESE stories were collected by the author during a period covering nearly three years and were told to him by Bara of various ages and classes. They are the traditional tales of the country and may be told by anyone; but the usual narrator is an old man who amuses his audience at the same time as he instructs them in traditional behaviour. While the stories themselves remain constant, the tunes to which they are sung vary, and since 1900 a considerable change in the accompaniments has been noted. The tales may illustrate ritual or other customs, or may be what we should call entirely mythical, though the natives themselves appear to make no distinction between them in credibility. In this volume the stories are arranged and classified, and there are two maps showing the extent of the knowledge of the Malagaches dialect and of the tales themselves.

K. R.

USE OF RADIOACTIVE TRACERS IN BIOLOGICAL RESEARCH*

By Prof. F. A. PANETH, F.R.S.
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IF a chemist is asked to report on the use of the new tracer technique in biology, it is obvious that he is expected not to discuss the scientific problems, but the laboratory technique. The direction of the whole work, from the first planning of the experiments to the final interpretation of the results, must lie in the hands of the biologist, and all that a chemist or, for that matter, a physicist or technician, can hope to contribute is advice as to the most efficient use of tools of research which may be unfamiliar to the biologist. The ideal organisation for such a task is a team of scientific workers; it will be the more efficient the better the biologists and their helpers understand each others' points of view. This survey is meant as a contribution from the side of radiochemistry to such mutual understanding.

The introduction of tracer methods into science has been likened to the invention of the microscope in the seventeenth century. One can scarcely imagine anyone writing to-day about "The Use of the Microscope in Biological Research"; but that was largely the subject of Robert Hooke's "Micrographia" and of Leeuwenhoek's rambling letters to the Royal Society. If the power of a new technique is to be demonstrated, one must try to show its applicability to various scientific problems instead of concentrating on the thorough discussion of one of them; the desultory character of such writings can scarcely be avoided and will, it is hoped, not be too much felt in this commentary on the tracer technique.

The first tracer experiment was carried out in the Vienna Radium Institute as early as 1913; it was, however, only ten years later that G. de Hevesy used a radioactive indicator in the investigation of a biological problem; he studied the distribution of lead in a plant growing in a solution containing active lead. The choice of lead was dictated by the very limited number of suitable radioactive tracers available in those days; but lead is not one of the elements the uptake of which by a plant we are particularly anxious to study, and the very fact that the experiment was nevertheless undertaken shows how clearly its author had realized the potential importance of the tracer method for biology.

Only after the discovery of artificial radioactivity in 1934, and the production from then on of active isotopes of a great number of lighter elements, could biological research make full use of the tracer technique. About the same time methods were developed also for the separation of inactive isotopes, as, for example, oxygen of atomic weight 18, or nitrogen of atomic weight 15, which can often be used as indicators in the same way as the radioactive nuclides (atomic species). The method of their detection is different, usually more difficult—as it needs often a mass spectroscopic analysis—and less sensitive. But the basic principle of 'labelling' an element by the addition of an isotope is the same, and much important tracer work in biology has been carried out with inactive isotopes by R. Schoenheimer, D. Rittenberg and others.

Radioactive tracers can be useful in three different groups of experiments. With their help we can detect: extremely small quantities of a substance; extremely small fractions of a given substance; and the exchange of molecules or atoms of identical chemical properties. In this third group of experiments inactive tracers can very often take the place of radioactive tracers; in this survey, however, we shall only occasionally refer to isotopic tracers in this wider sense of the word.

To-day the biologist is in the fortunate position of being able to choose from the large variety of radioactive tracers which are offered in Great Britain by the Atomic Energy Research Establishment, in Canada by the National Research Council, and in the United States by the Atomic Energy Commission. The accompanying table comprises the most important of these tracers.

Element	Isotope	Half-life	Element	Isotope	Half-life
1	^{3}H	31 y.	41	^{95}Nb	36 d.
6	^{11}C	20·5 m.	42	^{99}Mo	67 h.
	^{14}C	5100 y.	43	^{99}Tc	10^{6} y.
9	^{18}F	2 h.	44	^{103}Ru	42 d.
11	^{22}Na	3·0 y.		^{106}Ru	1 y.
	^{24}Na	14·8 h.	46	^{103}Pd	17 d.
14	^{31}Si	170 m.	47	^{110}Ag	225 d.
15	^{32}P	14·3 d.		^{111}Ag	7·5 d.
16	^{35}S	87·1 d.	49	^{114}In	48 d.
17	^{36}Cl	10^{6} y.	51	^{122}Sb	2·8 d.
	^{38}Cl	37 m.		^{124}Sb	60 d.
18	^{37}A	34 d.		^{125}Sb	2·7 y.
19	^{42}K	12·4 h.	52	^{129}Te	32 d.
20	^{45}Ca	180 d.	53	^{131}I	8 d.
21	^{46}Sc	85 d.	54	^{135}Xe	9·4 h.
22	^{51}Ti	72 d.	55	^{137}Cs	33 y.
24	^{51}Cr	26·5 d.	56	^{131}Ba	12 d.
25	^{54}Mn	310 d.	57	^{140}La	40 h.
26	^{55}Fe	4 y.	58	^{141}Ce	30 d.
	^{59}Fe	44 d.	59	^{143}Pr	19·3 d.
27	^{60}Co	5·3 y.	63	^{154}Eu	5–8 y.
28	^{59}Ni	15 y.	73	^{182}Ta	97 d.
29	^{64}Cu	12·8 h.	74	^{185}W	77 d.
30	^{65}Zn	250 d.	75	^{186}Re	90 h.
	^{69}Zn	13·8 h.	77	^{192}Ir	70 d.
33	^{74}As	16 d.	79	^{198}Au	2·7 d.
	^{76}As	26·8 h.		^{199}Au	3·3 d.
	^{77}As	40 h.	80	^{197}Hg	64 h.
34	^{75}Se	125 d.		^{203}Hg	51·5 d.
35	^{82}Br	34 h.	81	^{206}Tl	3·5 y.
36	^{85}Kr	4·5 h.	83	^{210}Bi	5 d.
37	^{86}Rb	19·5 d.	84	^{210}Po	140 d.
38	^{89}Sr	55 d.	85	^{211}At	7·5 h.
39	^{90}Y	65 h.	93	^{239}Np	2·3 d.
40	^{95}Zr	63 d.	94	^{238}Pu	50 y.

In judging the suitability of tracers, the biologist will have to consider above all their half-lives (shown in the table). Remembering that, after the lapse of ten half-value periods, less than 1 per mille of the active substance is left, he will try to find a tracer with a half-life comparable to the duration of the experiment planned. Next he will have to calculate the degree of dilution his tracer is likely to undergo; his scientific collaborators will then be able to tell him how much activity has to be used at the start, taking into account the character of the rays emitted. Finally, the necessary specific activity (that is to say, number of disintegrations per second per gram of substance) will have to be discussed. In general, the biologist will be in favour of the highest obtainable specific activity, as there is always the danger that the introduction of weighable quantities of a chemical may create non-physiological conditions; but he should not demand more than seems really necessary, as the insistence on high specific activity—perhaps even on a 'carrier-free' radioactive tracer—is likely to make the task of its preparation much more difficult for the nuclear physicist and the chemist. It is the latter's job to separate the tracer nuclide chemically, after it has been produced by the fission process of uranium, or by the bombardment of stable elements with neutrons or deuterons. This analytical-chemical separation can often be considerably simplified if a small amount of the stable isotope is added; such a process is, however, irreversible and results in the permanent lowering of the specific activity. If the biologist thinks he must insist on the avoidance of this dilution, he will have to tell the chemist whether any other element may be added as a carrier, and in what quantity. Any non-isotopic element can, at least in principle, be removed again, and thus the specific activity increased.

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* Substance of two Special University Lectures delivered in the School of Pharmacy in London on January 26 and 27, 1949.

It has always to be kept in mind that a radioactive tracer introduced into a biological system may also cause some alterations owing to its rays. For this reason the necessary total activity discussed above should not be much exceeded; nor should, at least in experiments on humans, the half-life of the radio-nuclide be of a higher order than the duration of the experiment, as it is very inadvisable to introduce any permanent activity. During recent years there has been a tendency on the side of medical men to reduce more and more the limit of tolerance for radioactive rays. In plants, too, it can be surprisingly low; it has been found that as little as 10 microcuries of phosphorus-32 in 1 litre of the culture solution may impede the normal development of the roots. If there is any suspicion that the rays of the radioactive tracer might have influenced the experiment, it will be extremely useful to apply a check by means of an inactive isotopic tracer, using, for example, carbon-13 alternately with carbon-14.

Before the biological experiment can get under way, it will frequently be necessary for the chemist to introduce the radio-nuclide into a particular organic substance. Such syntheses may be difficult, not only because the quantities to be handled are very small, but also because the radioactive material is so valuable that the chemist must try to get as nearly as possible the whole of it incorporated in the desired molecule and, inside the molecule, in the right place. Elegant methods have been developed, for example, for the labelling in an organic acid of either the carbon atom in the carboxyl group or, alternatively, the carbon atom in the α-position; or again, for quantitatively converting carbon dioxide—in which form the nuclide carbon-14 is usually delivered—into organic compounds more suitable for biological experiments. It is very gratifying that the United States Atomic Energy Commission is offering some tracer elements already in compounds which the biologist can utilize more easily; for example, carbon-14 in the sodium salt of several aliphatic acids, in steroid hormones, testosterone, etc.

A further difficulty may arise from the short life of the radioelement, which may compel the chemist to give preference to a quick-working procedure even if the yield is poor. Let us assume that we have to deal with a substance of half-life one hour, and that a satisfactory organic synthesis (100 per cent yield) would take 10 hours, while a very indifferent one (10 per cent yield) can be carried out in one hour. The first method would give us less than 1 per mille of the desired product, the second 5 per cent.

In some cases no skill of the chemist will be able to label a molecule just in the place where the biologist would like it, at least not permanently. A limit may be set by the ordinary chemical mobility of the atoms; usually the chemist will be able to give a warning as to the positions where exchange reactions may take place and give spurious results. There is also the possibility that the desired molecule is so complicated that its synthesis has not yet been achieved. Some substances of great biological importance belong to this group, for example, digitalis, insulin or penicillin. Fortunately, the biologist will in certain cases be satisfied with the second-best solution, that is to say, with a molecule which is radioactively labelled but in which the exact place of the radio-nuclide is not known. By forgoing this latter condition, the biologist makes it possible for us to use a variety of biological methods for the synthesis of tracer substances. We can, for example, grow plants in an atmosphere of carbon dioxide which is enriched in carbon-14; animals can be fed on these plants, and their excretion products may be used as fertilizers. The name 'isotope farming' has quite aptly been used for this process. If we have started with young plants and animals, we can be sure that the carbon-14 will be uniformly distributed throughout their carbon content, and there is scarcely any substance in the animal or vegetable kingdom which we may not hope to obtain in this or a similar way in a radioactive form. Thus the red blood corpuscles of 'donors' have been labelled with both iron-55 and -59 by simply injecting these radio-nuclides intravenously.

After completion of the biological experiment, the chemist's services will usually be needed for the analysis of some organs. It is true that in some favourable cases the distribution of the radioactive tracer can be followed up from outside the organism by measuring its γ-rays; such experiments are quite spectacular and can be used for medical diagnoses; in most cases, however, a β-radiation has to be investigated, and that means the careful removal of tissues and often the chemical extraction of biochemical substances.

It seems appropriate to mention here a very general analytical procedure, 'analysis by isotopic dilution', although it is not strictly speaking a tracer method, since it introduces the radioactive material for analytical purposes after the experiment is completed. The method can be of great help in all such cases where a quantitative determination of a substance seems to demand its complete extraction in a pure state. These two conditions are often more or less mutually exclusive, as, for example, if one particular member of an organic homologous series is to be extracted; losses are unavoidable if satisfactory purification has to be achieved. However, if we mix with the substance in question a known quantity of an isotopic substance of measured specific radioactivity, this activity will be reduced to a degree dependent on the quantity of the original substance present, and it will then be sufficient to separate only a fraction of the mixture in a pure state in order to calculate this amount. Let us assume that g gm. of specific activity s_1 are added to the x gm. originally present, and that, after careful mixing, the specific activity has been reduced to s_2. The specific activities must be inversely proportional to the masses in which the constant amount of activity is distributed; hence $s_2 : s_1 = g : (g + x)$, or

$$x = g \, \frac{s_1 - s_2}{s_2}.$$

From this simple formula it is clear that for finding x, only s_2 has to be measured; and as this can be done in any unknown fraction of the total mixture, quantitative extraction is no longer demanded. On a limited scale, analysis by isotopic dilution was used already in 1927 by R. Ehrenberg in his 'radiometric micro-analysis' and has more recently found wide application in the hands of H. H. Ussing and others. Inactive isotopes can, of course, be used equally well as radioactive ones, and one of the most impressive applications, the determination of oxygen in organic substances, has been made with oxygen-18.

The number of biological researches in which radioactive tracers have been used to great advantage is already so vast that we cannot attempt even to enumerate all the principal subjects. Let us mention just a few outstanding ones[1]. Radioactive hydrogen (tritium) and carbon-11 and -14 have been employed in the study of photosynthesis, and radioactive sodium, potassium and chlorine in the study of the permeability of cell membranes in animals and plants; radioactive iron has been used to measure the average life-times of red blood corpuscles and to follow up their fate in stored blood. Radioactive phosphorus helped in exploring the mechanism of the fertilization of the soil and of the metabolism of teeth. One of the best studied tracers is radioiodine; it has long been known that this element is concentrated in the thyroid gland, but tracer methods helped very considerably in a deeper understanding of the building up of the two main constituents of the hormone and of the influence that the removal of the thyroid and pituitary glands has on their production. The metabolism of the bone salt has been studied with the help of radioactive calcium, strontium and plutonium. Since it has become known that beryllium can be highly toxic, the exact mapping of its distribution in the body by means of its active isotope beryllium-7 is important.

Before concluding, I should like to direct attention to a biological tracer experiment which Nature carries out constantly and on a scale infinitely greater than anything attempted by man. The most important element in organic life is carbon, and it is just this element which Nature labels by the admixture of carbon-14 wherever it occurs in biological processes. This isotope has a half-life of about 5,000 years; it can be produced in uranium piles by the impact of neutrons on a nitrogenous substance:

$$^{14}_{7}\mathrm{N} + {}^{1}_{0}n \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H}.$$

The same nuclear process goes on in the highest layers of the atmosphere under the influence of the neutron-containing cosmic rays; the carbon atoms then combine with the oxygen of the atmosphere to give carbon monoxide and dioxide. As we now know that the atmosphere, contrary to earlier views, is so efficiently mixed up by winds that its composition is practically uniform throughout its height, we must expect the carbon dioxide everywhere on the earth's surface to contain the same amount of the long-lived radioelement carbon-14; measurements by W. F. Libby and A. V. Grosse—which are difficult owing to the weakness of the activity—have confirmed this.

The biological implications are obvious. Any plant, by assimilation of the atmospheric carbon dioxide, incorporates also the small percentage of carbon-14, and from there it gets into the bodies of animals and men; but its life-time is limited. In coal and oil deposits of considerable geological age, the activity must have vanished; it was thus according to expectation when it was found that methane from oil-fields is inactive, but that methane from a sewage disposal plant contains the standard amount of carbon-14. The same difference was found between alcohol from coal and alcohol from grain. Determinations of the age of bones (measured in thousands of years) seem possible in principle, but involve, among other things, assumptions about the constancy of the cosmic radiation about which we cannot be too sure. To-day, however, any carbon participating in the life-cycle is labelled; the old distinction between 'organic' and 'inorganic' chemistry, which has passed through so many phases, seems again to have acquired a new meaning.

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[1] References to the original papers can be found in the surveys by: Kamen, M. D., "Radioactive Tracers in Biology" (New York: Academic Press, Inc., 1947); Hevesy, G., "Radioactive Indicators" (New York: Interscience Publishers, 1948); Süe, P., "Dix Ans d'Application de la Radioactivité Artificielle" (Paris: Société d'Éditions Scientifiques, 1948); Fourth and Fifth Semi-annual Report of the U.S. Atomic Energy Commission (Washington, D.C.: U.S. Government Printing Office, 1948 and 1949). The vast predominance of biological experiments in to-day's applications of the tracer technique may be contrasted with the situation twenty-two years ago; see Paneth, F. A., *Nature*, 120, 884 (1927).

METHODOLOGY OF SCIENCE IN THE SERVICE OF THE ARTS

By F. I. G. RAWLINS
National Gallery

THIS title is intended to be distributive, in that its object is to introduce an examination of the methodology of 'science in the service of the arts', rather than the methodology of science 'in the service of the arts'. The implication is that there is, in fact, an activity recognizable in the sense of the first of these phrases. We are not concerned with a discussion of this point: the existence of such laboratories as those at the British Museum, the National Gallery, the Courtauld Institute (University of London), the Fogg Museum (Harvard University), the Museum of Fine Arts, Boston, U.S.A., and the Central Laboratory of the Belgian Museums (Brussels), is enough to decide this elemental question. Further, and in so far as the present theme has much in common with the theory of knowledge, the work carried on at the Warburg Institute, London, and at the Dumbarton Oaks Research Library, Washington, D.C., is relevant. These studies are iconographical and historical in the scientific sense. They constitute an essentially methodological framework and outlook.

The position is not wholly unlike that underlying the use of statistical and analytical processes in the social sciences. Here, without a doubt, the basis must be a sound methodology coupled with an acute appraisal of what can and what cannot ethically be done. In the immediate context much the same applies; fundamental mistakes have arisen in consequence of the assumption that laboratory tools can answer questions of style and taste. Such an outlook is manifestly absurd. Not only can no reply be expected; even some harm may be done to the cause of scientific method itself. One way to reduce, and perhaps largely to eliminate, this risk is to plan laboratory work deliberately upon first principles (including a generous use of historical perspective), introducing the special cases to be dealt with as they come along. By these means, the temptation to use the natural sciences as a 'new toy' (just to see what they can do) is kept in check.

An example is the use of X-rays to help in the task of attribution of a painting. At one time this performance was quite popular, not only among experts, but even in courts of law. With little understanding of what X-radiation is, and still less of the complex nature of its transmission through a stratified manifold such as a picture, confident assertions were made that such-and-such was the work of a certain master, and that something else rather like it was the effort of a student, or even perhaps a forgery.

In a recent instance, radiography proved exceedingly powerful, first in showing that certain pictures were executed over older painted canvases, and secondly in demonstrating the existence of two systems of fissures, one due to the contraction of the original paint and ground, and another characteristic of the recently applied visual design. Such an investigation reveals no confusion of purpose; what was sought for were matters of fact. For example, was or was not the 'picture' as commonly observed contemporary with the canvas upon which it was painted? The answer was in the negative; but radiography alone offered no opinion about who painted it.

The legitimate uses and limitations of the scientific method are thus perfectly clear. It is the task of others, pressing towards the truth maybe by other paths, to attempt a solution of the problem of attribution. Their own particular methodology is partly statistical (however unconscious), in that they weigh in their minds a large number of paintings known on independent data to be by a certain person, and 'balance' them against the sample. Partly, too, the scheme is æsthetic, in that appeal is made to a trained judgment upon the presumed artist's sense of beauty, composition, and fitness.

Thus, we are gradually becoming aware of the strivings going on to produce a new æsthetics; not an activity in any way at variance with the traditional discipline, but something at once more objective and, in the psychological sense, more highly integrated.

This means a greater emphasis upon experimental methods, quantitative wherever possible, and less perhaps upon abstractions relating to the nature of the sublime. Baumgarten's introduction of the term 'æsthetics' in the middle of the eighteenth century made it obvious that its aim was the quest for beauty, whereas that of logic was the quest for truth. In any system of methodology, however, it is ultimately the resolving power of the mind, and to what limits we are prepared to press it in the search for truth, which matters.

The point at which an integrated æsthetics can become confluent with much of scientific method is that at which descriptive and classificatory principles begin to emerge. It is probably not an accident that much the same criterion applies in focusing epistemological illumination upon the special problems of the social sciences. For they, in their turn, have conditioned (or at least the raw material out of which they are fashioned has conditioned) much of our cultural heritage, which we are now beginning to use as documents for a methodology in this particular field, namely, the scientific aspects of the arts. That some success, however limited, has already attended the introduction of the *Gestalt*-concept into the teaching of design is perhaps not without significance.

Historical Development: a Study in Morphogenesis

One has only to contemplate the majesty of the Athenian acropolis as it once was to become convinced that the Greek genius for form was allied to, and to some extent inseparable from, its outstanding accomplishments in mathematics. The same coupling appeared in a much attenuated form centuries later when the Tuscan algebraist Pacioli brought Leonardo da Vinci to think about ratios, and to study abstract quantity. Pacioli was no genius; he has bequeathed some interesting thoughts in his "Divina Proportione", and he compiled what might fairly be called a standard text-book of mathematics. Nevertheless, he was a close friend of Leonardo (who designed the illustrations for his book, published in Venice in 1509), and a natural inference is that his manipulative skill—modest as indeed it was—was enough to encourage the great artist to turn towards the study of natural law. Vietá, some half a century later, in developing a true sense of algebraic form, paved the way for that liberal species of thinking which in time led up to the foundation of a deliberate subject of æsthetics. The influence of environment in all this is naturally by no means negligible. John Ruskin's essay, "The Two Boyhoods"[1], depicts the youthful Giorgione under his Italian sun, and Turner in Soho and on Wapping Old Stairs. So far as their art is concerned, the contrast is more than a particularly effective literary device; it is an example of morphogenesis in action, clear enough to satisfy any functional biologist.

One is thus constrained to seek a unifying principle, as mankind, in spite of many lamentable failures, has struggled on in purposeful effort to realize the beautiful. It is here that methodology is at some slight advantage in view of the possibility of making qualitative criteria at least semi-quantitative. Broadly, the unifying factor seems to be symmetry: it is as if our morphogenetic plan started with a triclinic crystal, and culminated in a cubic one, a continuous increase in symmetry. Just as solids exist which have no symmetry whatsoever, so are some objects utterly devoid of beauty. The interesting moment, however, is when at least one element of symmetry can be envisaged, and the human mind grasps the conceivability of advance towards the highest types of organisation. In this connexion it is tempting to ask what is the nature and position of amorphous systems in such a hierarchy. Are they for ever outside the range of æsthetic significance? Most likely in themselves they are; but not 'for ever', in consequence of their capacity, under certain extreme physical conditions, to crystallize, and so to begin the steep ascent to perfection. In Aristotelian terms, common clay is in potency to pass into entelechy as the sapphire.

Intellectually—and this is important for the formal aspect of all methodologies—the same coercive impact upon abstract problems, the solution of which is at present unknown, is necessary if thought (and mental mastery) is to crystallize out as new knowledge. It is the 'logical pressure' demanded by Milne[2] in his work upon an adequate epistemology of physics.

The metastable and labile states of matter exhibit a suggestive parallel here. The *status quo* is obstinately maintained until the system is so completely out of energy-balance with thermodynamic necessity that change of state comes about imperatively. Correspondingly, man's course has at times been set towards new æsthetic states, which are, in the event, only achieved convulsively, when the compelling effect of creative drive and social conditions together provide the minimum of 'requiredness'. Again, as in physics, a remarkable degree of 'supercooling' can be tolerated so long as disturbance, either psychological or by the infiltration of new ideas, is avoided. An example can be seen at Barnack. Here the mixture of styles, Norman and Early English in the nave of the parish church, is due to the remote location : the trend of architectural design was unknown in its entirety, and thus a hybrid resulted. Cases of this kind must be distinguished from the forced compliance with a new technique which is known to have been brought about at various places in Europe by the invasion of neighbouring tribes. Alternatively, direction from a powerful centre, as in Carolingian times, may have occurred.

The analogue of 'logical pressure' may be expected to set in sooner or later. This would be an 'æsthetic pressure', the goal of which might be the discovery of new forms of beauty, corresponding to the search for new manifestations of truth. We shall discuss in the next section what this may involve ; for the moment, our task is predominantly historical. Here we may point out that much semi-conscious thought has evidently been devoted to speculation about new types of beauty in the past. The result is seen in the transitional nature of architecture (as already described), and in the gradual evolution of ceramics. More theoretically, the perspective of Andrea Pozzo, who was born in the same year as Newton, demonstrates morphoplastically how the Italian tradition gave place to the Baroque as the scientific activity of the Renaissance provided facts upon which to rear the edifice of deliberate three-dimensional 'effects', superposed upon a standard two-dimensional continuum.

Here, the influence of technique becomes noticeable, in its effect upon æsthetic advance. Broadly, the power of the craftsman over his materials has increased with the centuries. At the same time, new substances (for example, coal-tar colorants and thermoplastic polymers) have been placed in his hands by the labours of the chemists. Thus the possibility, though not necessarily the actuality, of artistic expression tends to increase, and with it the need for methodological control, or at least for some intellectual restraint. The position at the moment is difficult to assess, with any degree of confidence. Emphasis upon functional design (for example, factories, laboratories, and so forth) tends almost automatically to the negative virtue of the suppression of superfluous ornament. At the same time, it seems, never have we been less sure of ourselves, and therefore less willing to venture and experiment with new forms of expression. The same semi-Puritanical touch may be observed in other fields, leading to a kind of starvation of ritual and all that it implies.

A condition of neutral equilibrium seems to have set in, which may well be connected with the absence of 'glory' from the modern world, so poignantly expressed by Lord Russell in one of his Reith Lectures.

Some Axiological Considerations

The hope was once expressed by Whitehead that eventually æsthetics, ethics and even theology might be brought within the scope of symbolic logic. In so far as such an all-embracing scheme might be competent to achieve what, in principle (perhaps even in faith), Descartes and Leibniz viewed as from the summit of Mount Pizgah, we cannot but welcome it. But what exactly is it expected to do ? Any methodology applicable, through science, to the arts must clearly take account of value. It is precisely the lack of such a provision which rules out traditional Cartesianism, and indeed makes it wholly inacceptable in 'meta-situations', wherein human creativeness is most active. But modern (non-Aristotelian) logic is capable of doing exactly what is wanted, namely, to lift æsthetics (and the axiological core embedded in it) out of the bog of controversy, and to set it firmly upon a rational basis. This, however, is not likely to come about until æsthetics—ever seeking new beauty as logic ever seeks new truth—is willing to allow the 'meta' element to act inwards. Thus metaphysics becomes potent as soon as it is conceived as science acting critically towards itself. Correspondingly, therefore, we now envisage a new 'meta-æsthetics', that is, beauty criticizing itself (a thing it never does at present), and thus advancing, painfully, no doubt, along the way of sorrows, to the status of a true *scientia*.

If it be objected that there can be no possible justification for the use of yet another 'meta' subject, while the proto-discipline is so backward, or at least so wayward, the answer assuredly is that mankind's deepest experience proves the opposite. The advance of meta-mathematics, meta-languages (semantics and semiotics), and, in general, metatheory during the present century, has been most remarkable. Why not then admit at once the desirability (however difficult) of a corresponding move towards the sublimation of the beautiful ?

It is important to realize the 'dimension' in which all this is already taking place. It is neither 'upwards' nor 'sideways' : it more nearly resembles the driving in of piles and concrete to support the structure of some great medieval cathedral. Knowledge and creativeness both get tired as the centuries pass. It is not to their discredit ; on the contrary, it is an index of how liberally they have spent themselves from generation to generation. But it is time to look to the foundations, and occasionally to the "rock whence we are hewn". Few people seem to care overmuch for work of this description, with little to show for it. It is like tapping and making good beneath the lowest levels of the crypt. By all means, however, let work go on above ground at the same time, in any desired direction. All branches of mathematics and natural science are reaching out both vertically and horizontally. They, when they can, are lending æsthetics a hand, by help in the conservation of her 'documents', and a care for her outward achievements.

Thus our methodology begins by sensing the depth of the axiological problem in the quest for beauty. In harmony with what is happening to the exact sciences, it urges the need for attention in the basement. When that is safely under way, maybe the youthful meta-æsthetics will take shape comparatively painlessly ; for while opportunities for self-criticism will be numerous, they can be pursued in peace.

There is another possible gain, this time from the flank. Those whose task is shielded to some degree, and whose aim it is to re-inforce structures 'without interrupting the traffic', acquire a remarkable grasp of each others' problems and difficulties. In this way it is conceivable that concord over a wide sector of human relationships will tend to advance.

If these are ends (even perhaps necessities), how are we to orientate ourselves to reach them ? Manifestly, an educational proposition is presented, not so much novel as coercive. Its essential character is preparation for a new type of spade-work. That will take time. Luckily, there are already signs that the cracks in the superstructure have been noticed. Two examples, both recent, will illustrate. First, discussions on the possible reform, in certain major respects, of the Natural Sciences Tripos at Cambridge have led to proposals for the inclusion of historical and philosophical studies in the curriculum and examinations[3]. It is too early as yet to anticipate what the result will be; the important point is that such views should have been expressed, and that with no lack of vigour and seriousness.

The second portent is the formation of a Group, affiliated to the British Society for the History of Science, to study the philosophy of the sciences in the widest possible sense, including symbolic logic and æsthetics. (The relevance of all this to Whitehead's expression of faith already mentioned will not be overlooked.) So far, the new venture promises well.

Next, in what way or ways can people, by either of these movements, be influenced to behave axiologically, that is, perform valuable service? The answer is contained implicitly in the Cambridge report. There is a need, it suggests, for a new type of administrator, with a scientific background and habit of mind. What better than that he or she should be fashioned on these generous lines? To achieve distinction at the highest level in this new field must not be easy. If arrangements are adequate, it will certainly be no 'soft option'. Probably it assumes a degree of maturity more complete than is always the case, though that is in itself no reason why as much as possible should not be done at a less specialized stage. It should, moreover, be capable of interesting students in the faculty of fine arts, and thus to sow the seed in potentially fertile soil. Æsthetics has need of a magnanimous and strong methodology to support it. No longer should be heard within it such words as "Those [are the wounds] with which I was wounded in the house of my friends"[4].

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[1] Ruskin, "Modern Painters", **5**, Part 9.

[2] Milne. The Scott Lecture, *Proc. Roy. Soc. Edin.*, **62**, 10 (1943).

[3] *Cambridge University Reporter*, November 9, 1948.

[4] Zechariah, xiii, v. 6.

NEWS and VIEWS

Zoological Society of London:
Mr. H. G. Maurice, C.B.

Mr. Henry Gascoyen Maurice has been awarded the Gold Medal of the Zoological Society of London, in recognition of his great services to the Society. This Medal has been awarded only three times previously since its foundation in 1877. Mr. Maurice has been a member of the Council of the Zoological Society almost continuously since 1926, and was president during 1942–48; since retiring from the office of president he has continued to serve as a vice-president. He took office in the middle of the War, at a very critical time in the history of the Society, and it was largely the result of his wise conduct of its meetings that the various difficulties of those years were overcome. Mr. Maurice's long interest in natural history and Nature protection covers a wide range. He was fisheries secretary at the Ministry of Agriculture and Fisheries during 1912–38. His wide knowledge of problems connected with the fishing industry made him an ideal president of the International Council for the Exploration of the Sea, a position he occupied for eighteen years. On his retirement he was appointed 'president d'honneur', and in 1937 awarded the Gold Medal of the Johannes Schmidt Foundation for Oceanographical Research. Since October 1936, he has been secretary of the Society for the Preservation of the Fauna of the Empire, and editor of its journal; and, in addition, he has taken a very active part in all problems connected with Nature protection. He was in charge of the British delegation to the meeting at Fontainebleau in October last year, which resulted in the foundation of the International Union for the Protection of Nature; and he was elected a vice-president and member of the executive council of this Union. Some of Mr. Maurice's fascinating essays on natural history have recently been issued in book form, "Sometimes an Angler" and "The Wisdom of the Ass".

British Agricultural Advisers in North America:
Dr. W. F. Darke

The Agricultural Departments and the Commonwealth Relations Office announce that Mr. J. A. Young, assistant agricultural adviser to the High Commissioner for the United Kingdom in Ottawa, is returning to Northern Ireland in April at the end of his period of duty in Canada. His place will be taken by Dr. W. F. Darke, who will have the rank of secretary (agriculture) in the High Commissioner's office. Dr. Darke entered the University of London in 1930, taking his B.Sc.(Econ.) degree in 1933. He was awarded a research scholarship by the Agricultural Research Council and worked at Oxford and at the University of California. In 1936 he was awarded the degree of Ph.D.(Econ.) (London) and a year later that of B.Litt. by the University of Oxford for part of his work on the history of the smallholdings movement. Dr. Darke was appointed to the staff of the Ministry of Agriculture and Fisheries in May 1938 as a junior economist. He was seconded to United Nations Relief and Rehabilitation Administration in August 1944, and in 1947 took up duty with the Food and Agriculture Organisation; he returned to the Ministry of Agriculture in January last year.

Mr. M. W. Taylor

The Agricultural Departments and the Foreign Office announce that Mr. P. J. Macfarlan, assistant agricultural attaché in the British Embassy at Washington, is returning to the United Kingdom in May on the completion of his two-years appointment, and will be replaced by Mr. M. W. Taylor. Mr. Taylor went to Emmanuel College, Cambridge, and studied agriculture. During 1933–41 he was engaged in poultry farming on his own account, after which he was appointed senior biology master at Clitheroe Royal Grammar School. Later he became technical adviser and superintendent of the experimental farm for the

Poultry Association of Great Britain. Mr. Taylor was appointed to the staff of the Ministry of Agriculture and Fisheries in December 1946 as a poultry advisory officer in the National Agricultural Advisory Service.

Mr. C. S. Windebank

MR. C. S. WINDEBANK has been appointed managing director of the Esso Development Company. This Company conducts and co-ordinates research, contract and patent work for the benefit of the Esso group of petroleum companies in Europe. Mr. Windebank took first-class honours in chemical engineering at the University of London, and in 1936–37 was at the Massachusetts Institute of Technology, where he was awarded the degree of M.Sc. In 1937 he joined the technical staff of International Association (Petroleum Industry), Ltd., in London, and later, in 1940, he was released from the Army in order to undertake technical work with Esso European Laboratories on aviation fuels. On the formation of the Esso Development Company in 1947 Mr. Windebank was made manager of the Research Department.

Royal Society of Edinburgh : New Fellows

THE following were elected fellows of the Royal Society of Edinburgh at the ordinary meeting held on March 7 : Dr. Charlotte Auerbach, 9 Fountainhall Road, Edinburgh 9 ; Dr. R. S. Barclay, statistician to the West Highland Survey ; Dr. W. Black, principal scientific officer to the Scottish Society for Research in Plant Breeding ; John Cameron, sheriff of Inverness, Moray, Nairn, Ross and Cromarty ; Prof. W. H. J. Childs, Physics Department, Heriot-Watt College, Edinburgh ; Dr. Ethel D. Currie, University of Glasgow ; Dr. D. P. Cuthbertson, director of the Rowett Research Institute, Bucksburn, Aberdeen ; Dr. A. M. Gillespie, 135 Craiglea Drive, Edinburgh 10 ; Mr. D. Grant, 19 Falcon Road West, Edinburgh 10 ; Dr. F. Gross, Zoology Department, University of Edinburgh ; Mr. J. Jack, Mayfield, Monktonhall, Musselburgh, Midlothian ; Prof. R. V. Jones, Natural Philosophy Department, University of Aberdeen ; Dr. Sheina M. Marshall, principal scientific officer, Scottish Marine Biological Association Laboratory, Millport ; Mr. N. G. Matthew, 126 West Savile Terrace, Edinburgh 9 ; Dr. Christina C. Miller, Chemistry Department, University of Edinburgh ; Mr. H. C. Pawson, assistant director and senior tutor in agriculture, King's College (University of Durham), Newcastle-upon-Tyne ; Dr. I. A. Preece, 7 Blinkbonny Road, Edinburgh 4 ; Dr. Doris L. Reynolds, 7 West Mains Road, Edinburgh 9 ; Dr. H. O. W. Richardson, Natural Philosophy Department, University of Edinburgh ; Dr. H. Sington, London ; Dr. J. Smart, Zoology Department, University of Cambridge ; Dr. R. H. A. Swain, Bacteriological Department, University of Edinburgh ; Mr. G. Waterston, Harestanes, Longniddry, East Lothian ; Mr. R. G. White, director of the Animal Breeding and Research Organisation, Agricultural Research Council ; Dr. F. N. Woodward, director of the Scottish Seaweed Research Association.

Use of the Term 'Coliform'

THE term 'coliform' has for some time had an obscure meaning, and it has become increasingly clear that a definition is desirable. Those interested in medical and veterinary bacteriology have used it to embrace only the morphological characters of many species, not of *Bacterium coli* alone, but also of the dysentery bacteria, the salmonella and other Gram-negative rods similar to *Bacterium coli*. On the other hand, the term 'coliform' is restricted by many water and dairy bacteriologists to those organisms which are not only morphologically similar to *Bacterium coli* but which also resemble it in its cultural and biochemical characteristics ; some have even regarded it as being synonymous with *Bacterium coli* of fæcal origin. Because of this confusion and also because there is now a closer liaison between all those who study bacteria from whatever aspect, a committee of nine representing this variety of interests was appointed by the Society for General Microbiology and by the Society for Applied Bacteriology. This committee met on several occasions to discuss various aspects of the matter, and it is hoped that bacteriologists in general will be able to agree upon the meaning of the term 'coliform' which has been put forward.

Dr. Reginald Lovell (for the Society for General Microbiology), Royal Veterinary College, London, N.W.1, and Dr. C. B. Taylor (for the Society for Applied Bacteriology), c/o Messrs. Lever Brothers and Unilever, Ltd., Port Sunlight, Cheshire, have forwarded the following relevant portions of the committee's report : "(1) The term 'coliform' means 'like *Bacterium coli*', or 'coli-like'. (2) 'Coliform' is an adjective, and as such has no generic or ecological significance. (3) It is proposed that the term 'coliform' should refer to Gram-negative rods resembling *Bacterium coli* in morphology and staining reactions, but not necessarily in cultural and biochemical characteristics. (4) That the widest publicity should be given to this definition to prevent the term being employed to define different specific types by different workers, or to restrict the term to particular branches of bacteriology. The committee is convinced that the proposed definition is the only one satisfactory to all interests in bacteriology and is opposed to any definition based on ecology or biochemical reactions. Existing systems allow for classification of organisms grouped under the wide term now proposed."

University of Birmingham

AT the annual meeting of the Court of Governors of the University of Birmingham, the Pro-Chancellor, Mr. Sydney Vernon, announced that the progress of building at the University would be accelerated in the present year by an increase in the available supplies of material and labour. Among the first requirements to be met is the extension of the students' union. At present a part of the new engineering building is well advanced, and it is hoped that a further portion will be undertaken very shortly. The estimated cost of the much-needed halls of residence is such as to postpone indefinitely their realization. Present needs have been met to some extent by the erection of a number of prefabricated huts which are regarded as temporary, though they appear to be more durable than the old wooden Army huts erected in 1919, some of which are still in use. The doubling of the University population during the ten years following the War was regarded as being in the national interest ; but Birmingham has already more than achieved this aim, the present number of students being between 3,250 and 3,500, a figure at which the Vice-Chancellor considers it might well be stabilized.

Among experiments aimed at broadening the education of the undergraduate, mention was made of the action in the Department of Electrical Engineering, where Prof. A. Tustin has eliminated much detail from third- and fourth-year honours courses to make room for lectures and discussions on philosophy, literature, economics, and the impact of the natural sciences on society. The students are expected to write a substantial essay each session on some topic outside their professional syllabus, and a departmental library of books on non-technical subjects has been provided. The results so far appear highly satisfactory. The problem of staff salaries has been accentuated by the recommendations of the Spens Report. Whatever solution is found, the effect on university welfare will be profound. The problem is not one of standard of living but of competition for the best human material, without which the costly measures being taken to give university education to a greater proportion of the best of the youth of Great Britain will not produce the results they should.

University of Natal

The University of Natal is celebrating at Pietermaritzburg on March 15 and Durban on March 19 the granting of a charter to the University which became effective at the beginning of this year. Sir Raymond Priestley, vice-chancellor of the University of Birmingham, Lord Eustace Percy, vice-chancellor of the University of Durham, and Prof. J. Dover Wilson, formerly regius professor of rhetoric and English literature in the University of Edinburgh, are visiting South Africa for these celebrations. They are travelling under the Commonwealth University Interchange Scheme initiated by the British Council as a result of recommendations made at the Congress of Universities of the British Commonwealth last July. Under the scheme the Council will award travel grants to university teachers travelling on recognized study leave; distinguished scholars invited for short visits; and postgraduate research workers holding research grants. The grants are made on the recommendation of a committee representing the Association of Universities of the British Commonwealth, the Committee of Vice-Chancellors and Principals of the United Kingdom, and the Universities Advisory Committee of the British Council.

Exchequer Grants for Universities in Britain

Sir Stafford Cripps, Chancellor of the Exchequer, in a written answer in the House of Commons on March 1, stated: "I am providing £12,814,500 for recurrent grants to universities. This amount includes provision for the additional expenditure which universities will incur in bringing into operation the revised scales of payment for teachers in the medical and dental schools. . . . The progress of the universities' scheme for physical expansion necessitates an increase in the amount required for non-recurrent grants, and I am providing £4¾ million for this purpose as against £2,600,000 this year."

Effects of the Mild Winter

The unusually mild weather over the greater part of the winter of 1948–49 in England and Wales has not only produced many remarkably interesting phenological observations, but also substantially contradicted the various theories and averages upon which amateur and professional meteorological observers forecast a probably severe winter for this period. Indeed, one London wild-life quarterly produced in the winter of 1948–49 a paragraph: "Nature-wise observers predict an unusually severe winter". Their reasons were: "(1) There has been an unusually heavy crop of wild berries. (2) Squirrels have been noticeably active in gathering and storing nuts. (3) Flocks of wild geese from Iceland and Russia have arrived earlier than usual. (4) Wild swans are arriving in considerable flocks. . . . (5) In the Highlands the deer have left their mountain fastnesses a month earlier. . . ." In each case the oft-quoted forecast had been disproved even so recently as the mild winter of 1947–48, which followed an abundant berry crop—the result of a previously good growing season. Very large flocks of pintail and wigeon have been recorded on the Cheshire Dee despite the mild winter.

January was free from the cold and snowy conditions usually prevailing at this time of the year. On January 24 a mallard duck was reported with a nest of four eggs in a hollow tree at Worcester College, Oxford, and it had increased its clutch to seven by January 27. In North Wales the lesser celandine was in flower from January 9 at Llanarmon, as was the water-crowfoot, and by the third week dog's mercury, hazel and barren strawberry were in flower. The coltsfoot was first reported flowering in Cheshire on January 16, compared with the thirty-five years average date of March 3. Hazel catkin flowers appeared seventeen days earlier than the thirty-five years average. The chiffchaff has been reported wintering in southern England. In Shropshire the chaffinch was first heard in song on January 31 compared with February 6 in 1948, February 5 in 1944, and February 7 in 1943. The Merseyside Naturalists' Association recorded forty species of plant in flower by March 1, 1949, compared with April 1, 1948.

The Eyasi Skull

The June 1946 issue of the *Journal of the East Africa Natural History Society* contains two articles, one by Dr. L. S. B. Leakey entitled "Report on a visit to the site of the Eyasi skull found by Kohl-Larsen", and the other by W. H. Reeve on "A geological report on the site of Dr. Kohl-Larsen's discovery of a fossil human skull, Lake Eyasi, Tanganyika Territory". In the course of an expedition to the region of Lake Eyasi in Tanganyika Territory during 1934–36, Dr. Kohl-Larsen discovered there parts of three human skulls, together with some artefacts and fossil mammalian remains. The actual site is situated on the flats bordering the lake, and is approximately at the level to which the water rises during the wet seasons. The fossil human skull came from the so-called bone bed, a deposit of slightly consolidated sand. As the Eyasi deposits have not been disturbed, they must be subsequent to the earth movements which immediately followed the Middle Pleistocene in those regions. There seems, however, no reason, either on archæological or geological grounds, to question their late Pleistocene age, a date assigned to them by Dr. Kohl-Larsen. It may be added that the Eyasi strata contain minerals often found in Olduvai Bed 5, which also belongs to the same period.

Archæology in the Vaal River Basin

The Archæological Survey of the Union of South Africa has recently published a pamphlet entitled "Early Man in the Vaal River Basin" (Archæological Series, No. 6. Pretoria: Government Printer, 1948. 5*s*.). This interesting paper includes an article by Prof. H. Breuil on the earlier stone-age finds in the

Vaal River area; a second by Dr. C. van Riet Lowe on the older gravels of the Vaal, their industrial contents and the relationships with successive pluvial and interpluvial periods, while a third, by Dr. A. L. du Toit, is a note on the older gravels of the Vaal between Barkley West and Windsorton. Much important work is being done just now in South Africa not only in correlating the various cultural stone-age levels with the successive climate changes, but also in the intensive typological and technological study of industries made mainly from non-flint material. The raw material occurs in large blocks; and the frequent occurrence in Stellenbosch industries of the so-called Clacton platform would seem to show that this method of breaking up large blocks of raw material is in no sense typical of any particular culture, but was used freely when fashioning a nucleus from large lumps of refractory material. The diagram correlating the various phases of the Stellenbosch culture and the middle and later stone ages with the climate changes will especially interest students and give rise to some earnest thought. Dr. du Toit's note is purely geological and is concerned with the actual formation of the various gravels. This series of pamphlets issued by the Survey is always interesting; but to those concerned with correlations and the earlier industries this number is of very considerable importance.

Mortality of Adult and Young Mallards

A RECENT examination by E. O. Höhn of the recovery data of mallards (*Anas p. platyrhynca*) ringed under the *British Birds* marking scheme shows an interesting difference in length of survival of birds ringed as adults as compared with those ringed as young (*British Birds*, 41, No. 8; August 1948). Ringing recoveries of 305 adult mallards showed that 65·3 per cent died during the first year after ringing, 23·9 per cent during the second year, 6·6 per cent during the third year and 4·2 per cent during subsequent years. The average length of further survival from the date of ringing was one year and two months. Of 828 mallards ringed as young, 89 per cent died during the first year after ringing, 9·6 per cent during the second year, 0·6 per cent during the third year and 0·8 per cent during succeeding years. The average period of survival was 4·5 months after ringing. The mortality recorded by Höhn is almost entirely due to shooting.

Photometric Elements of a Binary Star

A PAPER by R. L. Baglow (*Mon. Not. Roy. Ast. Soc.*, 108, No. 4; 1948) on "The Photometric Elements of *RS* Sagittarii" is based on R. O. Redman's observations of the star, a description of which has already been published (*Mon. Not. Roy. Ast. Soc.*, 105, 212; 1945). Redman's measurements were made photographically by the Fabry method and refer to an effective wave-length of 4400 A.; these are shown in two figures together with a theoretical curve for both minima, computed by Baglow. Tables were calculated for various degrees of darkening, utilizing those given by Russell and Shapley, and elements were finally computed for an assumed coefficient of limb-darkening u equal to 0·4. The spectral type of the brighter star is given as *B*5, but that of the fainter one has not yet been observed. For the purpose of calculating the correction for reflexion it was assumed to be of type *A*0; but until its spectrum has been observed the absolute dimensions of the system cannot be accurately determined, nor can the observed ellipticity of the components be compared with theoretical expectations. Table 3 of the paper shows the dimensions of the system for three different assumptions of the mass ratio, 1·0, 0·5 and 0·2, leading to the radii of the relative orbits as 4·7, 7·0 and 14 million km., respectively. It is believed that *RS* Sagittarii is a normal eclipsing binary with a circular orbit, the secondary star being considerably less massive than the primary but comparable in size with it. Suitable spectroscopic observations of the system could greatly reduce the large uncertainties in the photometric results.

Board of Greenkeeping Research: St. Ives Station, Bingley

AT the annual meeting of the Board of Greenkeeping Research in Leeds on February 11, 1949, the director of the St. Ives Research Station, Mr. R. B. Dawson, presented his report on the Station's activities during 1948. In spite of a shortage of staff, the work has increased, and research has continued on many of the old experiments put down early in the Station's history. New work has been done on soil stabilization with bitumen, seeds mixtures, growth substances for the control of weeds, and worm control. The advisory work carried out during the year has been very heavy. Visits to subscribing clubs, the Station's postal advisory service and the number of samples from clubs which were handled by the laboratory, all showed substantial increases in the 1948 figures as compared with 1947. In addition to the pH, lime requirement and the phosphate status, the reports of the laboratory analyses of club samples now include the potash status. Golf clubs in Great Britain have continued their support, and there has been a marked increase in the support from municipalities and clubs. Educational work has been kept up in that many lectures have been given to outside bodies, and six courses of instruction for groundsmen have been arranged at the Station.

British Commonwealth Specialist Agricultural Conference in Australia

IN accordance with the resolution of the 1946 British Commonwealth Scientific Official Conference, a Specialist Conference in Agriculture will be held in Australia during August 22–September 15, 1949. The theme of the Conference is "Plant and Animal Nutrition in Relation to Soil and Climatic Factors", with emphasis on 'nutrition' interpreted broadly as well-being, and it is intended that the meeting shall consist of informal discussions between workers actively engaged in this field. The Conference, which is being organised by the Australian Council for Scientific and Industrial Research, will commence in Adelaide, South Australia, for the period August 22–31, when sessions *A*, *B*, *C* and *D* will be held. This will be followed by an official twelve-day tour through southern South Australia, Victoria and southern New South Wales, and the final sessions, *E* and *F*, and winding-up will be at Canberra during September 13–15. Official invitations have been made to each member country of the British Commonwealth, and some fifty delegates will be nominated. In addition, some invited contributors from other countries, from the United States, for example, will be attending. Travelling expenses and subsistence of the delegates will be borne by their respective countries; but the Australian Government is financing the twelve-day tour. The papers for the Conference will fall into three main groups: (*a*) officially invited papers; (*b*) contributed papers, which may be submitted without invitation and must not exceed 2,000 words; (*c*) summaries or abstracts, which are the same as (*b*) except that the limit is 500 words. Papers will not be read, but will be circulated in advance; and to facilitate printing, copies should be sent to the author's national committee immediately. Full details may be had on communication to the Secretary, Conference Committee, Specialist Agricultural Conference, c/o Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, Australia. The telegraphic address is: Coresearch, Melbourne.

Conference of Industrial Research Directors

A CONFERENCE of Directors of Industrial Research is being held during March 11–14 at Ashorne Hill, Leamington Spa, Warwickshire, under the auspices of the Industrial Research Committee of the Federation of British Industries. The chairman of the Research Committee, Sir Wallace Akers, is presiding. The subjects under discussion include relationship between the research department and management and other departments of the industrial organisation; finance and costing, laboratory administration and scientific staff, research programmes and their formulation; application of results of research to production; publications, publicity, information and intelligence; and relationship with research associations, the Department of Scientific and Industrial Research and other Government departments, and universities.

Lectures in Lausanne on the Tubercle Bacillus

A COURSE of lectures on current scientific research concerning the tubercle bacillus is being organised in Lausanne by Prof. P. Hauduroy, director of the Institute of Hygiene and Bacteriology of Lausanne, during April 21–23, 1949. The lecturers will include Prof. K. A. Jensen (Copenhagen), Prof. P. Hauduroy (Lausanne), Dr. Chain (Rome), Sir Howard Florey (Oxford) and Dr. J. Tréfouel (Pasteur Institute, Paris). The lectures will be given either in French or in English, and a summary in both languages will be distributed beforehand to members of the audience. Each lecture will be followed by a discussion. The enrolment fee is 15 Swiss francs. Particulars can be obtained from Prof. P. Hauduroy, 19 Avenue César Roux, Lausanne.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: J. M. Hay, assistant chemist, Nigeria; C. H. Tack, forest engineer, Uganda; J. Greasley, veterinary officer, Tanganyika; P. T. Heath, veterinary officer, Uganda; G. J. Bell, professional assistant, Royal Observatory, Hong Kong; R. J. Garner, assistant meteorologist, Gold Coast; N. G. Lechmere-Guppy, assistant conservator of forests, British Guiana; A. P. Johnson, assistant meteorologist, Gambia; N. Kirby, deputy Government chemist, Jamaica; R. D. Pauwels, agricultural chemist, Kenya; J. K. Cox (agricultural officer, North Borneo), senior agricultural officer, North Borneo; J. Gordon (agricultural officer, Gold Coast), agricultural officer, North Borneo; R. D. Linton (senior agricultural officer, Tanganyika), deputy director of agriculture, Gold Coast; His Highness Tenghu Yaacob ibni al-marhum Sultan Abdul Hamid (principal agricultural officer, Federation of Malaya), State agricultural officer, Federation of Malaya; J. F. Hughes (assistant conservator of forests, Tanganyika), forest utilization officer, Tanganyika; M. S. Parry (assistant conservator of forests, Tanganyika), sylviculturist, Tanganyika; Dr. J. H. Strahan (malaria research officer, Federation of Malaya), professor of social medicine and hygiene, Singapore; L. F. Robertson (senior veterinary officer, Palestine), veterinary officer, Tanganyika; S. Simpson (senior veterinary officer, Gold Coast), director of veterinary services, Gold Coast; L. J. Chwatt (malariologist, Nigeria), senior malariologist, Nigeria; K. V. Nicholls (meteorological officer, Federation of Malaya), meteorologist, East African High Commission; G. K. Read (animal husbandry officer, Palestine), livestock officer, Tanganyika.

Announcements

H.R.H. The Princess Elizabeth, Duchess of Edinburgh, has been elected an honorary member of the Royal Institution.

SIR ROBERT ROBINSON, president of the Royal Society, has been elected an honorary member of the Parliamentary and Scientific Committee.

MR. HUGH LINSTEAD, M.P., secretary of the Pharmaceutical Society of Great Britain, has been elected a foreign corresponding member of the Academy of Medicine of France. The Academy, which is the premier medical society of France, was founded in 1820 by Louis XVIII, and its membership is limited to 270 French and 80 foreign members.

THE Bessemer Medal for 1949 of the Iron and Steel Institute has been awarded to Prof. J. H. Andrew, professor of metallurgy in the University of Sheffield.

THE University of Liverpool Chemical Society Medal for this year has been awarded to Prof. F. S. Spring, of the Royal Technical College, Glasgow. The presentation will take place at the annual open meeting of the Society, when Prof. Spring will deliver an address entitled "The Chemistry of Aspergillic Acid".

DR. J. F. DANIELLI has been appointed to the University chair of zoology tenable at King's College, London, as from October 1, 1949.

THE Rockefeller Foundation has made a grant of 15,000 dollars for the purchase, primarily, of infra-red spectroscopic equipment in the United States, for use in the University Chemical Laboratory, Cambridge, under the direction of Prof. A. R. Todd. The equipment is to be used in developing and furthering researches in that Laboratory on nucleotide and nucleic acid structure, and on other chemical investigations of biological importance.

THE second award of £50 of the Oliver Memorial Fund will be made to a British subject for a notable contribution to the research, organisation or donor aspect of blood transfusion. Applications and suggestions should be sent, before June 30, to Mr. F. W. Mills, National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

THE British Iron and Steel Research Association is to hold a conference during May 9–10, 1949, at Ashorne Hill, near Leamington Spa, to discuss the practical applications and essential theoretical treatments of phase-contrast microscopy, the multiple-beam interference technique, and the reflecting microscope. Application to attend and for accommodation at Ashorne Hill should be made to the Metallurgy Division, B.I.S.R.A., 11 Park Lane, London, W.1.

LETTERS TO THE EDITORS

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Role of Dislocations in Crystal Growth

THE theory of nucleation in the formation of liquid or solid phases from the vapour, the most detailed treatment of which in any published work is that by Becker and Döring[1,2], is in satisfactory quantitative agreement with experiment with regard to the primary nucleation of liquid droplets[1,3], which requires saturation ratios of from 3 to 6 in typical cases. The theory predicts further that the primary nucleation of a crystal from the vapour requires still larger saturation ratios, so that the critical conditions for nucleation of the liquid are reached first, unless working with very low vapour pressures far below the melting point. This is also in agreement with observation.

In the course of their treatment, Becker and Döring also deal with the two-dimensional nucleation of each new close-packed layer of molecules deposited on a crystal face, the importance of which was first stressed by Volmer. The theory indicates that just as the three-dimensional drop or crystal is far more likely to evaporate than to grow larger unless it exceeds a certain critical size, the same is true of a two-dimensional 'island' of new crystal layer on a completed crystal face, when this face is of a close-packed or 'saturated' character: for example, the (100) face of the Kossel model crystal made of cubic building blocks for which Becker and Döring made their calculations, or of sodium chloride; or the (111) face of a face-centred cubic crystal of argon.

No one seems to have noticed that the assumption that the growth of crystals from the vapour takes place in this way (by two-dimensional nucleation in the crystal surface) implies a rate of growth which is negligible at small supersaturations.

According to the theory developed by Volmer and Becker and Döring, the number of nuclei formed per second on 1 cm.^{2} of surface is

$$N \sim A \exp\{-\varphi^2/(kT)^2 \log \alpha\}, \qquad (1)$$

where A is of the order of 10^{20}, φ is the interaction energy between two molecules, and α is the saturation ratio, that is, the ratio of the concentration in the vapour to the equilibrium concentration. Experiments by Volmer and Schultze[4] in iodine at 0° C. indicate an observable rate of growth proportional to $\alpha - 1$ when $\alpha \geqslant 1{\cdot}01$. The value of φ/kT for iodine at 0° C. is about 6, so when $\alpha = 1{\cdot}01$, the exponent in (1) is about $-3{,}600$. In fact, the observed growth-rate exceeds the theoretical value by a factor of $e^{3,600}$.

Two of us (W. K. Burton and N. Cabrera)[5] have re-examined in detail the bases of the Becker–Döring theory. The most important refinement concerns the shape of the critical nucleus. Becker and Döring restricted their attention to rectangular nuclei, and found the critical one to be a square of side

$$l_0 = \varphi/kT \log \alpha \qquad (2)$$

measured in molecular spacings. We find, in fact, that it is a figure with rounded corners which can be inscribed in the same square (Fig. 1). The shape is independent of α but depends on φ/kT. Between two corners the shape is given by

$$y/l_0 = \log_e\{1-[\sinh^2(\varphi x/2kTl_0)]/\sinh^2(\varphi/4kT)\}. \qquad (3)$$

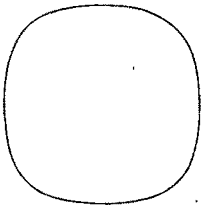

Fig. 1

The radius of curvature at the corner is given by

$$\rho/l_0 = -(\sqrt{2}kT/\varphi)\tanh^2(\varphi/2kT), \qquad (4)$$

so that the shape tends to a square in agreement with Becker and Döring at sufficiently low temperatures.

In the general case, (1) can be written

$$N \sim A \exp(F/2kT), \qquad (5)$$

where F is the edge free energy of the critical nucleus, valid for all shapes of nuclei. The effect of the correction is to reduce F in the same ratio as the area of the critical nucleus. This ratio cannot be smaller than $\pi/4$, and is, in fact, $0{\cdot}86$ when $\varphi/kT = 6$. Thus the discrepancy between theory and experiment is still about $e^{3,100}$. Other corrections, connected with the details of surface migration processes, are relatively small, and we do not believe that the estimate of the value of φ can be wrong in order of magnitude. We are forced to the conclusion that the theory, as amended, gives the true order of magnitude of the rate of growth of a perfect crystal, and it has been suggested by one of us (F. C. Frank)[6] that it can only be reconciled with the observed rate of growth of real crystals by recognizing that those which grow are not perfect.

It is believed from their mechanical behaviour that real crystals in general contain dislocations. Taylor's original conception of a dislocation has been generalized by Burgers[7] with the recognition that the unit displacement of the dislocation is not necessarily normal to the dislocation line, and may, in an extreme case, be parallel to it, in which case we have a Burgers 'screw' dislocation (Figs. 2 and 3*a*). Whenever a dislocation line which is wholly or partly screw terminates in the exposed face of a crystal, there is a permanently exposed 'cliff' of atoms in the surface, the addition of a new layer restores the initial situation, and the need for fresh two-dimensional nucleation is eliminated: with a single screw dislocation in the face, it can grow perpetually 'up a spiral staircase'. The exposed cliff now plays the part of the edge of the nucleus. In the case where there is a single dislocation in the face, if its distance l from the boundary exceeds l_0, growth will occur: if l is

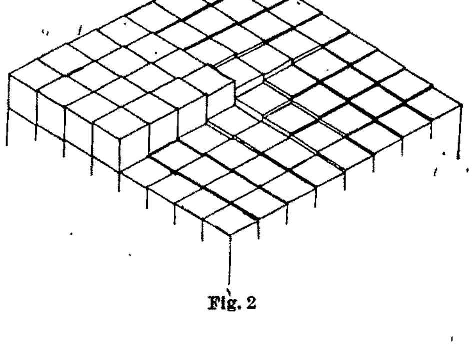

Fig. 2

less than l_0, evaporation will occur. Hence the smallest crystal which can grow by this mechanism must have a face of width greater than $2\,l_0$. This is also the critical size for three-dimensional nuclei in the classical theory. Two screw dislocations terminating in one crystal face give rise to the situation shown in Fig. 3*b*. Growth takes place freely if the distance apart of the dislocations and the distance of either of them from the edge of the face exceed l_0. The criterion $l > l_0$ for growth can be shown to be a sharp one, despite thermal fluctuations.

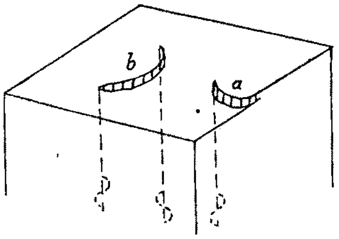

Fig. 3

We conclude that crystals do not grow at low supersaturations unless they contain dislocations. On the other hand, an excessive density of dislocations also inhibits growth, particularly at very low supersaturations: hence under these conditions we get the most nearly perfect, and yet never truly perfect, crystals. The growth of 'unsaturated' faces (for example, (111) faces of sodium chloride, or any faces of high index) is independent of dislocations or two-dimensional nucleation; but in the case of a crystal which has more than one family of relatively 'saturated' faces, which would need two-dimensional nucleation if it were perfect, it may be the dislocation structure which determines which are the slowest growing, that is, the habit faces.

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Velocity of Sound in Liquid Hydrogen

In continuation of our previous measurements on the velocity of ultrasonics (frequency 523 kc.) in condensed gases at low temperatures[1], we have now measured the velocity of sound in liquid hydrogen under its saturated pressure as a function of temperature between 21° and 14° K. The experimental results are given in the accompanying table, and graphically in Fig. 1.

During the measurements, we observed a pronounced increase of the velocity of sound as a function of time. Those observations were followed specially at the boiling point, and are represented in Fig. 2. This phenomenon is not due to a temperature drift, but probably to a transformation of the normal hydrogen to para-hydrogen in the liquid phase. In connexion with this phenomenon, we observed that the values which were obtained on November 26 are larger than the earlier ones, so that we are of opinion that the later measurements correspond to a more complete transformation into para-hydrogen.

Date	T(°K)	v(m./sec.)
Nov. 23, 1948	21·0	1150
,, 23, ,,	20·8	1173
,, 26, ,,	20·4	1229
,, 23, ,,	20·4	1190
,, 23, ,,	18·2	1251
,, 12, ,,	18·0	1260
,, 26, ,,	17·4	1278
,, 23, ,,	16·7	1271
,, 23, ,,	16·5	1265
,, 12, ,,	16·3	1274
,, 26, ,,	14·8	1340

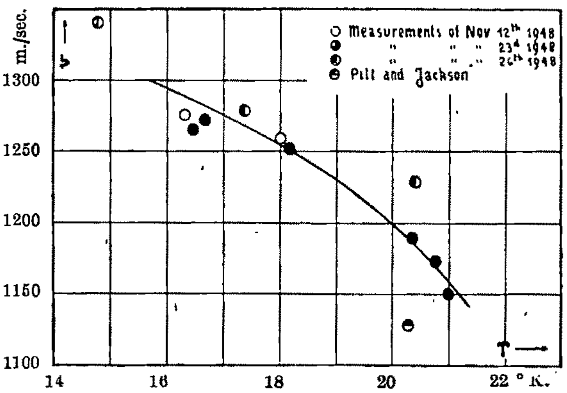

Fig. 1

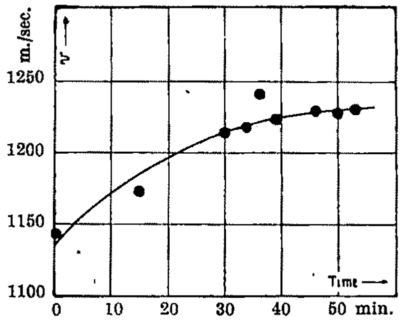

Fig. 2

Recently, one measurement at 17 ± 1° K. on the velocity of sound by using the pulse technique has been published by Galt[2]. He found at this temperature, $v = 1{,}187$ m./sec., which is smaller than our values, so that we suppose that his measurements correspond to normal hydrogen. Pitt and Jackson[3] measured the velocity of sound at the boiling point of hydrogen; their value is also indicated in Fig. 1.

We take the opportunity to express our sincere thanks to the Fonds National de la Recherche Scientifique for financial help.

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Dec. 1.

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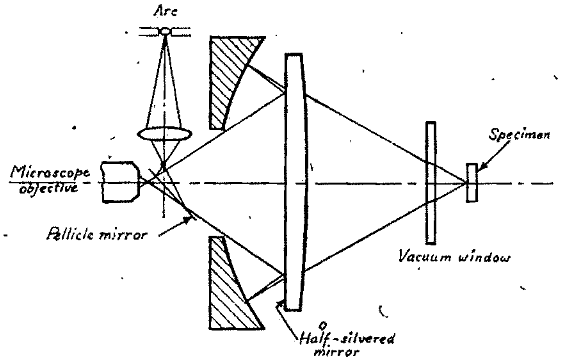
A Unit-Magnification Optical System with Long Working Distance for Microscopical Applications

Occasions frequently arise in microscopy where a working distance much greater than that given by conventional objectives for a given numerical aperture is required. This occurs in the microscopy of hot metallurgical specimens inside a vacuum furnace, the examination of electrode conditions inside a vacuum tube, various biological applications, and the examination of nuclear plates which may involve working through considerable thicknesses of glass and emulsion.



A system designed to meet the conditions of the metallurgical problem outlined above is illustrated in the accompanying diagram. A concave spherical mirror is placed so that the object is nearly at its centre of curvature. Light from the object passes through a half-silvered plane mirror and falls on the concave mirror nearly at normal incidence, is reflected back to an image nearly coincident with the object, and is reflected a second time by the half-silvered mirror to form an image behind the concave mirror, which is perforated to allow the image thus formed to be examined by a conventional microscope objective.

The side of the half-silvered mirror nearer the object is worked to a weak convex curvature which enables the spherical aberration due to the vacuum window and to the half-silvered mirror plate itself to be corrected without introducing significant coma. By this means a numerical aperture of 0·5 can be obtained, corresponding roughly to an 8 m./m. microscope objective.

An experimental system has been made giving approximately this aperture with a working distance of about 34 m./m., as against the 2 m./m. of an 8 m./m. objective. Due to parasitic reflexions, a vertical illuminator cannot be used in the observing microscope in the usual way. Vertical illumination can be obtained by placing a thin half-silvered pellicle mirror at 45° in the beam converging to the final image, and reflecting light into the system as shown. An unwanted image of the light source is formed by two reflexions at the half-silvered mirror and one at the concave mirror; the system is so disposed that this image is displaced about 3 m./m. along the axis away from the image of the specimen. The hole in the centre of the out-of-focus image of the light source, due to the perforation in the concave mirror, then occupies the whole field of the observing microscope, and the image of the specimen is not obscured.

An immersion system using the same principle, with the concave and plane mirrors formed on two sides of a glass block, has been designed for nuclear plate work. This uses a 4 m./m. objective and attains a numerical aperture of 0·75, enabling the examination of nuclear tracks through a quarter of an inch or so of glass. It is small enough to be used on a conventional microscope.

A water immersion system for biological applications has also been designed.

A fuller description of these systems, together with the theory of the corrections, will be published elsewhere.

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Showers Generated in Lead by Mesons

The main source of secondary electrons produced by mesons at sea-level is the close ionizing collision in which considerable kinetic energy is transferred to the electron concerned, and from which a small cascade develops.

Many workers have observed such showers using a thickness of dense material greater than 30 cascade units in order to be sure that electrons coming from the air are excluded, and that equilibrium is reached between the meson beam and its electron secondaries[1,2]. The results obtained in this way generally agree; but with smaller collision layers, when the transition effects at the entry into the dense medium have not yet become stabilized, the agreement between different workers is not so satisfactory[3,4,5].

Clay and Venema[4] have measured the absorption of incident electrons but not the transition effect of the layer; Stuhlinger[3] has carried out correction measurements, the principle of which is certainly good, but which are not quantitatively comparable with his original data, since the area of the layer in

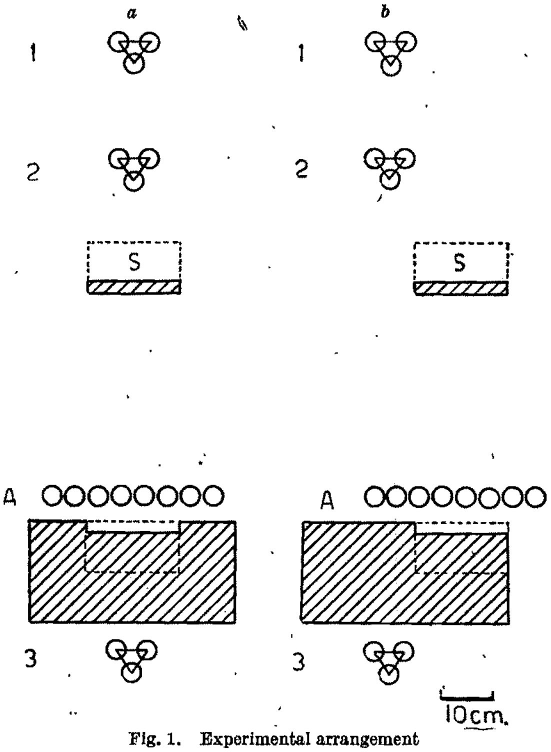

Fig. 1. Experimental arrangement

which mesons give rise to 'knock-on' electrons appears to be different from that used for the correction.

During a systematic research on showers produced by mesons, we have obtained a result which we think is of interest. The arrangement (Fig. 1) records, in addition to threefold coincidences 1, 2, 3, the number of counters triggered in the large tray *A*. Mesons give a threefold coincidence and may trigger one counter in *A*; accompanying showers may trigger further counters in *A*.

The circuit used will be described in a paper appearing shortly in *Nuovo Cimento*. The background-rate was measured using the method of Stuhlinger; but the arrangement is now changed so that the shower-generating layer is the same both for generation by mesons (Fig. 1*a*) and for the out-of-line experiment (Fig. 1*b*) which yields the correcting term. The correction can thus be applied directly.

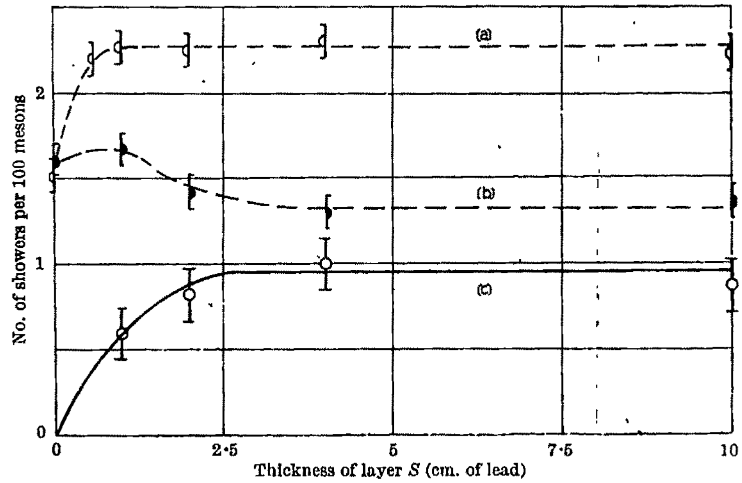

Fig. 2

In Fig. 2 we have plotted the number of showers recorded per hundred mesons as a function of the thickness *S* of the penetrating layer. Curve *a* corresponds to the arrangement of Fig. 1*a*, curve *b* to the arrangement of Fig. 1*b*, and curve *c* to the difference. Saturation is reached in curve *a* at about 1 cm. lead in agreement with the results of Stuhlinger[3] and Tongiorgi[5]. The maximum of curve *b* occurs also at the same position, as was observed by Stuhlinger. The corrected number of showers (curve *c*) is thus about 1 per cent of the number of mesons concerned.

Our arrangement is clearly insensitive to very low energy electrons, which will be very heavily scattered on leaving the lead plate. We estimate the cut-off energy to be appreciably greater than 10^7 eV. Our result is thus in general agreement with the result given by Nassar and Hazen[6], who used a cloud-chamber method to study these secondary showers.

The experiment is now being repeated using iron instead of lead.

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Aug. 26.

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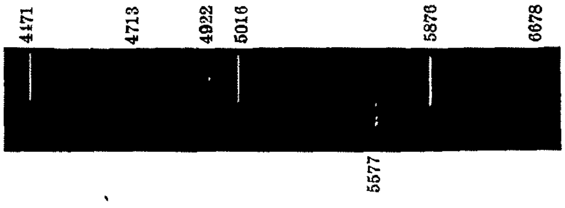
Afterglow Phenomena in Argon–Nitrogen Mixtures at Pressures Close to Atmospheric

In 1924, L. Vegard[1] directed attention to the occurrence of phosphorescent bands in the region of the auroral line at 5577·35 A. when a solidified mixture of nitrogen and argon or neon is exposed to cathode-ray excitation. In a recent communication, Vegard and Kvifte[2] report an observation of J. Nordhagen that pure argon at atmospheric pressure shows a green luminescence when excited by a Tesla transformer. Vegard and Kvifte suggest that the green band is a phosphorescent phenomenon initiated by the oxygen auroral line at 5577·35 A. They point out that increase in oxygen concentration above a certain value (not stated) suppresses the green phosphorescence.

Afterglow phenomena similar to those described by Vegard and Kvifte have frequently been observed by us when the argon–nitrogen filling of some tungsten filament lamps is excited by a Tesla transformer giving a discharge current of the order of 50 m.a. The gas-filling pressure in the lamps was 600 mm. o argon containing 8 per cent nitrogen. The accompanying spectrogram, taken in 1945, on an Ilford *HP* 3 plate shows the green oxygen line at 5577 A. and the band emission from the afterglow in the region 5600–5400 A. There is no trace on our photograph of the red band observed by Vegard in solidified gases.

It is known that the amount of oxygen in the lamps was certainly less than 4 p.p.m. of the gas filling. As little as 50 p.p.m. of oxygen or water vapour introduced into the lamp quenched the afterglow; hydrogen in similar amount had little or no effect. Burning the lamp for a hundred hours or so usually caused a gradual decrease in the intensity of the afterglow, and the optimum glow appears to occur at a concentration of oxygen probably considerably less than 1 p.p.m. Attempts to reproduce the afterglow in a lamp containing 'spectroscopically pure' argon under the same conditions have so far been unsuccessful, and our experiments show that nitrogen is a desirable, if not an essential, constituent of the gas filling.

In addition to the green afterglow we have sometimes observed in certain argon–nitrogen filled lamps afterglows lasting about a second of various colours from red to purple, the latter being indistinguishable in colour from that of the primary discharge. We have not as yet been able to record these afterglows photographically; but it is possible that the reddish



Tesla-discharge in an argon–nitrogen mixture, showing green auroral line and associated phosphorescent band (lower spectrum); discharge in helium (upper spectrum) glow is merely a rather feeble development of the well-known nitrogen afterglow.

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Cathodo-Luminescence of Rare Earths in Coal Ash

BY cathodo-luminescence I have detected[1] the presence of rare earths in certain minerals in quantities too small to be detected by arc spectrographic analysis.

Samples of a number of Indian coals (from Darjeeling, Assam, Raniganj, Jharia and Hyderabad) were incinerated in thin layers in porcelain basins in an electric furnace at 400° C. The presence of rare earths in the ashes so obtained could not be detected by arc spectrographic analysis with a current of 10 amp. and 220 volts, with an E_1 quartz spectrograph using pure carbon rods. Cathodo-luminescence was then tried. The coal ashes as obtained did not show any luminescence when excited by the cathode rays. But after mixing the ash with a sufficient quantity of calcium oxide, the cathode rays induced bright luminescence. This was caused by the presence of manganese acting as an activator in the presence of calcium oxide. When rare earths were also present in the coal ash, the manganese band was suppressed by the activating action of the rare earths. It was found that the best condition for excitation of the specimen was at a potential of 4,000 volts, the current in the tube being kept at 4 milliamp. The luminescence was then so bright that the time of exposure required for taking a spectrogram was 3–7 min. with the direct-vision spectrograph and 5–12 min. with the Fuess quartz spectrograph. Urbain's data for the different systems for rare-earth oxide in calcium oxide were taken as reference in identifying the line-like bands of the luminescence spectra of the specimen.

The rare-earth activators for luminescence in coal-ash were samarium, dysprosium, europium, erbium and probably terbium and neodymium. It was found that the luminescence of the ash from only a few samples of coal from Darjeeling, Assam and Hyderabad was caused by the presence of rare earths. Luminescence of all the ashes from samples of coal from Raniganj and Jharia was caused only by manganese. Some of the samples of ash contained rare earths in sufficient quantity completely to suppress the luminescence spectrum of manganese in the visible region. With smaller quantities of rare earths, both the rare earths and the manganese behaved as activators for luminescence. Those rare earths with even atomic numbers (samarium 62, dysprosium 66) were found to be the chief activators for luminescence.

Thanks are due to Prof. P. B. Sarkar, for helpful discussions, to Prof. M. N. Saha, for allowing me to use the spectrograph, and to the Director of the Geological Survey of India, for supplying the samples of coals.

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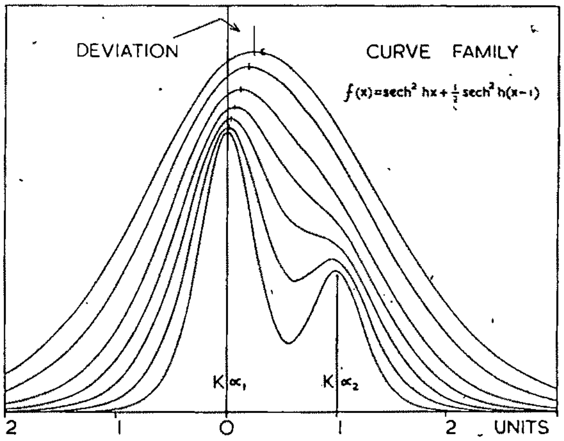
A Correction to the Diameter Measurement of Diffuse X-Ray Diffraction Rings

LATTICE parameter measurements of cold-worked metals are subject to an appreciable error if no provision is made for the lack of coincidence between the $K\alpha_1$ peak and the apparent peak, as measured, of the broadened doublet. This is indicated in the synthesized curves of the accompanying figure.



The geometrical subtraction method proving laborious, and in many cases uncertain, the following method of correction has been applied in recent work to obtain a better figure for lattice parameter. It depends upon a relationship determined between the width at half maximum intensity and the deviation between the $K\alpha_1$ and the apparent peak of the photometered doublet.

It was found that the practical doublets, when corrected for film response, approximated reasonably to the sum of two curves of the form

$$y = \text{sech}^2 hx,$$

the constant h being typical of a particular degree of broadening.

The $K\alpha$ doublet was synthesized from two such curves, having an intensity ratio of 2 : 1 and a unit $K\alpha_1 - K\alpha_2$ separation. This sum curve was defined by the following equation:

$$f(x) = \text{sech}^2 hx + \tfrac{1}{2}\,\text{sech}^2 h(x-1). \qquad (1)$$

Differentiation provided the condition for the maximum of this curve:

$$\text{sech}^2 hx.\ \tanh hx = -\tfrac{1}{2}\,\text{sech}^2 h(x-1).\ \tanh h(x-1). \qquad (2)$$

The sum curve (1) was plotted for a particular value of h, and the approximate abscissa for the peak estimated.

Open-scale plots were then made, for a small range of abscissa values about the approximate value, of $f'(x) = \text{sech}^2 hx.\ \tanh hx$ and $f''(x) = \frac{1}{2}\,\text{sech}^2 h(x-1).\ \tanh h(x-1)$. The intersection of these two lines gave the correct peak abscissa, with reference to the foot of the $K\alpha_1$ peak as origin. Substitution in equation (1) provided the corresponding ordinate.

To determine the half-width, an estimate of the positive and negative abscissa values was obtained from the plotted sum curve, and, using form (1),

$f(x)$ was plotted against x around each half value, to an open scale. The correct abscissæ were read from these plots at a value of $f(x)$ equal to half the peak ordinate already determined.

Repeating for various h values, chosen to cover the required field of broadening, a calibration was plotted of peak deviation against half-width of the sum curve. This calibration tended asymptotically towards deviation values of zero and of one third of the $K\alpha_1 - K\alpha_2$ peak separation. The accompanying figure shows a curve family for equation (1) for values of the constant h from 0·85 to 3·0.

The correction method can be modified to overcome the practical uncertainty of true film background level. Thus the practical background-level can be drawn to intersect the skirts of the doublet at some arbitrary distance on either side of the peak value. The correction curve is modified to a corresponding zero-ordinate level, which will vary with the degree of resolution of the doublet. The doublet width thus measured will not be the conventional half-width.

An error of about 15 per cent may be allowed in the correction method, as this compares favourably with the error in the peak estimation of diffuse doublets.

Applied to individual results, the method would prove tedious; but in cases where a large number of readings are to be analysed, or the use of a monochromator is impracticable, it will be found to provide rapidly an improved figure for lattice parameter.

Peak deviations found in recent experiments with steel tensile bars have amounted to the equivalent of 0·04 per cent in lattice parameter, of great significance in residual strain or similar determinations.

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Plotting Electron Trajectories

A NEW method of tracing electron trajectories in electron optical systems has been developed in this Laboratory. The method consists essentially in the use of a differential analyser to integrate the equations of motion of an electron, the components of acceleration of which are continuously determined by automatic measurements in an electrolytic tank.

The present tank is of the type using half-section models of the electrode system under investigation, with the surface of the electrolyte corresponding to a plane of symmetry. The longitudinal and radial components of electric field are measured by the voltages between three suitably placed probes mounted on a movable carriage. These voltages have to be converted into proportional rotations to be suitable for feeding the differential analyser, and this is done by means of self-balancing linear potentiometers, embodying conventional follow-up servomechanisms. A third similar potentiometer is used to keep the probes at approximately earth potential.

The rotations are each fed into a pair of integrators of the differential analyser in cascade, the outputs from the first integrators of each pair representing velocities, and those from the second, displacements. The displacements are coupled back to the probe carriage so that the system continuously integrates the equations of motion of an electron and the probes move along an electron path.

Tests have been carried out on an electrostatic two-cylinder lens, and the results agree adequately with the theoretical ones available. The lens used had a gap-width of 0·8 radii. Numerical integration has been done by Goddard[1] for the case of zero and unity gap-widths, while calculations of the spherical aberration coefficient C are available for zero gap-width only[2]. For an acceleration lens of voltage ratio 4·9 we find:

Gap	f/R	C	
$0{\cdot}8\,R$	7·95	105	measured
0	7·85[1]	120[2]	calculated
R	8·25[1]	—	

The accuracy is estimated at 1 per cent for f and rather worse for C.

In addition to simple ray tracing, including skew paths, the machine appears to be suitable for solving more complicated problems, including the effect of space charge, both by exact and approximate methods, and tracing trajectories in time-varying fields. It is possible to allow exactly for relativity effects.

The differential analyser has already been described[3], and our thanks are due to the Director of the Cambridge University Mathematical Laboratory for making it available to us.

It is hoped to publish a detailed description of the apparatus at an early date.

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Absolute Power Measurement at Microwave Frequencies

Nichols and Hull[1] have verified the Maxwell–Bartoli theory of radiation pressure experimentally to within 1–2 per cent by a torsion balance method, with a light beam carrying a power of about 0·1 watt.

Experiments are being made in the application of a similar technique to the absolute measurement of power at microwave frequencies. The power P to be measured is fed through a compensated waveguide T-junction[2] to a matched load. The third leg of the T-junction (preferably a circular guide supporting the H_{01}-mode) contains a movable short-circuiting plate so placed that no reflexion occurs at the junction. It can be shown that the force on the plate is $\frac{P}{2c} \cdot \frac{\lambda}{\lambda_g}$, where c is the velocity of light, λ the free space wave-length, and λ_g the guide wave-length in the third leg.

Measurement of this force is sufficient to determine P, knowing λ and λ_g.

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Deformation of Single Crystals of Tin in Solutions of Oleic Acid

THE work of Rehbinder and his co-workers on the effect of surface-active substances on the strength of crystalline solids has been followed with considerable interest in this laboratory. In a paper published with Lichtman and Maslennikov, Rehbinder[1] reports a 50 per cent decrease in the yield value of single crystals of tin and zinc when immersed in a 0·2 per cent solution of oleic acid in a non-polar paraffin oil. He also reports a five-fold increase in the electrical resistance of a single crystal of tin when elongated almost to fracture in the same solution, in comparison with the resistance of a specimen of the same orientation similarly extended in air. These effects are ascribed to the opening and extension of the micro-cracks in the crystal by the 'wedging action' of a film of liquid drawn into the micro-cracks by an adsorbed layer of oleic acid molecules. This principle of 'adsorption reduction of hardness' has been widely applied in various processes for the mechanical destruction of brittle bodies[2].

Crystal No.	Condition	Peak stress (gm./mm.^{2})	Elongation at peak (%)	Angle between specimen axis and		Critical shear stress S (gm./mm.^{2})
				slip plane χ_0	slip direction λ_0	
4·10	As prepared (*a*)	123	2·6	43	46	58
	Clean (*b*)	132	2·4			63
	Clean in paraffin (*c*)	112	1·0			53
	Clean in solution of oleic acid (*d*)	125	4·1			59
3·5	As prepared (*a*)	124	1·3	48	49	61
	Clean (*b*)	119	1·9			58
	Clean in paraffin (*c*)	108	0·8			53
	Clean in solution of oleic acid (*d*)	111	1·1			54
3·7	As prepared (*a*)	136	0·8	30	30	59
	Clean (*b*)	124	1·8			54
	Clean in paraffin (*c*)	129	1·3			56
	Clean in solution of oleic acid (*d*)	134	0·5			58

This effect is obviously of considerable importance for the theory of metallic friction and boundary lubrication. It was therefore decided, as a prelude to further work on the effect of surface-active substances on metallic friction, to repeat Rehbinder's experiments, using so far as possible the technique described by him.

The specimens used were single crystals of tin (99·98 per cent pure) approximately 1 mm. in diameter and 13 cm. in length prepared by the Kapitza method[3]. Orientations were determined by X-ray rotation diagrams and in some cases checked by goniometer measurements of etch pits. Taking the slip system[4] as (110) [001], crystals were selected the orientations of which were near $\chi_0 = 45°$, since Rehbinder and Lichtman[5] report that the depression in yield value is a maximum at this orientation (χ_0 is the angle between specimen axis and the slip plane). Each crystal was then cut into six specimens, four for tensile tests, and two for electrical resistance measurements.

Tensile tests were carried out using a Polanyi-type apparatus[6], the four specimens of one crystal being tested under the following conditions: (*a*) in air, as prepared, with an oxidized surface; (*b*) in air, but cleaned for two minutes in *N* hydrochloric acid, washed in hot water, dipped in *N* ammonium hydroxide to neutralize any remaining acid, again dipped in very hot water and allowed to dry in air; (*c*) cleaned as in (*b*) and immersed in B.P. paraffin oil; (*d*) cleaned as in (*b*) and immersed in the same paraffin oil with 0·2 per cent oleic acid by weight added.

The absolute rate of extension was constant, and the rate of elongation of individual specimens, which depended on their initial length, varied from 0·2 to 0·35 per cent per minute.

The results of three typical tests are given in the accompanying table. All tensile curves showed a definite peak at approximately 2 per cent elongation. The critical shear stress in the (110) [001] slip system was calculated from this peak stress.

It will be seen that, under the conditions of these experiments, alteration of the surface condition produces no significant change in the critical shear stress.

Similar negative results were obtained with a series of crystals in which χ_0 varied from 30° to 60°, at rates of elongation of 0·2–4 per cent per minute.

In his paper, Rehbinder does not specify the particular paraffin used. Since it seemed possible that the viscosity of the solution might have some effect on the magnitude of the 'wedging action', the experiments were repeated using hexadecane and kerosene as solvents to provide a wide range of viscosities. Again no effect was observed.

The two remaining samples of crystals used in the tensile tests were then elongated almost to fracture (150–200 per cent elongation) in air and in the original oleic acid solution. For the same elongation, no significant difference in electrical resistance was observed.

In view of the very large effects reported by Rehbinder, and of their wide application, these negative results are put forward with some diffidence in the hope that workers in other fields may be able to offer some explanation. Further work is in progress with other metals and surface-active compounds.

This work forms part of the general research programme of the Division of Tribophysics, Council for Scientific and Industrial Research. My thanks are due to Dr. S. H. Bastow for directing my attention to the problem and to Dr. W. Boas for helpful discussions.

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Oxalacetate Decarboxylation by Iron and Copper

The catalysis of oxalacetate decarboxylation by metallic ions constitutes a simple 'model' system, the properties of which may throw some light on the biological decarboxylation mechanisms. Kornberg, Ochoa and Mehler[1] have described the formation of an unstable complex between oxalacetate and aluminium ions, which possesses a characteristic ultra-violet absorption spectrum. Recent studies from this laboratory[2] have shown that iron and copper differ in many respects as regards their ability to accelerate the decomposition of oxalacetate.

The effects of iron and copper were therefore examined in the light of their ability to form complexes such as that with aluminium. A Beckman Model *DU* quartz spectrophotometer was used, measurements being made at room temperature in 1-cm. cells. The 100 per cent transmission blanks contained all the constituents of the experimental cells except oxalacetate.

The ultra-violet spectrum of oxalacetate depends intimately on *p*H. The light-absorbing constituent (that is, either the enol tautomer or possibly the oxalacetate ion) increases with increasing *p*H. It might be expected, therefore, that formation of complexes involving this form (as suggested to occur for aluminium ions by Ochoa's team) would be maximal at high *p*H values. This is found to be the case with cupric ions, *but not with ferric ions.*

In unbuffered solutions, the absorption spectra of the ferric and cupric complexes resemble each other closely, both possessing very marked bands with maxima at 270 mμ. The ferric complex, however, shows an additional faint band extending from 355 to 375 mμ. The copper complex decomposes much more readily than that of iron when the same metal concentration is used. Whereas the copper complex forms almost spontaneously (that is, in less than 30 sec.) at acid *p*H, the iron complex formation reaches a maximum only after 1–5 minutes (depending on the oxalacetate to ferric iron ratio).

Ferrous iron did *not* cause formation of a complex resembling the above two. This is unexpected, as manometrically ferrous iron has been shown to be an active oxalacetate-decomposing agent[3]. However, since that work was carried out at 38° C. in acetate buffer, and a strong oxygen uptake was observed, it may be assumed that conversion to ferric iron preceded the decomposition of oxalacetate. Results of the spectrophotometric examination suggest that ferrous iron as such may not be a catalyst for the decarboxylation of oxalacetate.

The effect of *p*H on the rates of formation and decomposition of the two metal-oxalacetate complexes shows that, in the case of iron, formation of the complex is maximal at the lowest *p*H. The decomposition-rate does not vary greatly from *p*H 1·1 to *p*H 3·2, but is much slower at *p*H 4·5. A steady rise in optical density at and above *p*H 6 was so unusual that the spectrum produced under those conditions was re-examined. It was found that the absorption peak at 270 mμ *was no longer formed*, and that the whole spectrum resembled that of oxalacetate alone. However, in the presence of ferric iron, the whole spectrum was of higher density. Thus, the effect of ferric iron at and above *p*H 6 seems to be to increase the amount of the light-absorbing form of oxalacetate without forming a complex.

In the case of copper, complex formation increases with increasing *p*H, and thus appears to be dependent on the amount of enol-oxalacetate or oxalacetate ions present. The decomposition-rate appeared to be maximal between *p*H 3·5 and *p*H 4·5, decreasing sharply on either side of that range.

These results confirm the differences between cuprous and ferric ions observed in the manometric work, and show once again the intimate connexion between catalytic effectiveness and *p*H. The investigation is being extended to the effect of buffers, and to the blood catalysis. Full details of this work will appear in the *Australian Journal of Experimental Biology and Medical Science.*

I wish to thank Mr. H. R. Marston for the use of the spectrophotometer, and M. L. Wellby for technical assistance.

This work was carried out as part of the programme towards elucidating the mechanism of oxalacetate decarboxylation by blood[4,3,5].

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Effect of Acridine Compounds on the Respiration of the Brain of the Six-Day Chick Embryo

In relating the effect of certain acridines on mitosis to that on respiration, the inhibition of the oxygen consumption of the isolated brain of the six-day chick embryo by these compounds has been measured. It is thought that a note on these results would be of interest as a comparison with the results of Albert and Marshall[1] on chick red cells infected with *Plasmodium gallinaceum.*

Compound	Percentage inhibition of respiration of isolated chick brain at concentration of :			Concentration producing pycnosis of dividing cells
	1 : 12,000	1 : 6,000	1 : 3,000	
5-Aminoacridine hydrochloride	14	31	45	1 : 125,000
5-Amino-1-phenyl-10-methylacridinium bromide	nil	nil	nil	1 : 55,000
5-Amino-10-methyl-acridinium bromide	nil	nil	nil	1 : 140,000
5-Amino-2-trifluoromethyl-acridine hydrochloride	68	100	100	1 : 110,000

These results were obtained by a modification of the Cartesian diver micromanometer, using buffered Tyrode solution as a medium, and are interpolations from curves relating inhibition of oxygen consumption to concentration.

Exposure of the isolated brain tissue to the acridine compounds resulted, within two hours, in swelling and fusion of the chromosomes in dividing cells (pycnosis). The concentrations producing this change are recorded in the table; at such concentrations there was no measurable inhibition of respiration.

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Properties of Branched Aliphatic Acids and their Behaviour in the Dog

In Fig. 1 are seen on the right the melting points and the tolerated amounts of alkylated succinic acids; on the left the behaviour of β-alkyl-adipic acids plotted in the same manner. Both pairs of curves demonstrate a curious concordance between the purely physical attributes of melting point and the biological behaviour in the dog. We have also studied the properties of acids with longer side-chains, but have not plotted these values in the figures. The curves differ more as the number of carbon atoms in the side-chains increases, the melting points ascending more slowly than the tolerated amounts. The concordance of the curves, we conclude, is connected with the steric hindrance of the short side-chain, which renders the growth of crystals more difficult, as well as the apposition to oxidative enzymes.

In order to learn more about the steric and energetic behaviour of such branched acids, we prepared α-alkylated stearic acids with 1–12 carbon atoms in the side-chain.

In Fig. 2 the melting points are shown; oscillation between the odd- and even-numbered branches is clearly seen. Only substrates of a very high degree of purity can be used for these studies; the usual alkyls of natural occurrence have, therefore, been replaced by substrate successively synthesized from short alkyl bromides and ethylene oxide.

The minimal areas of each acid according to the monomolecular film method of Langmuir (monolayers on water) are seen in Fig. 3. These areas, 19·5 A.^{2} for normal stearic acid, quickly increase from methyl to butyl; the areas increase more slowly from pentyl to heptyl, and they remain unchanged from octyl upwards. The curve of the *maximal* areas obtained for all acids under the same conditions has the same direction. From these results we conclude that the short alkyl groups, up to and including butyl, lie crosswise to the main chain, from pentyl to heptyl are mobile, and from octyl upwards the branched groups are bent back on themselves to lie parallel to the main chain.

The methylated higher acids are biologically important in respect to their occurrence in steroids, isoprene derivatives and in lipids of acid-fast bacteria. The acids we have synthesized are shown in the table.

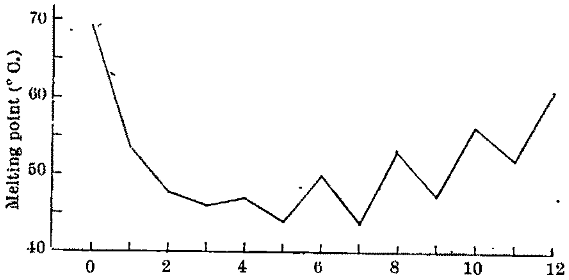


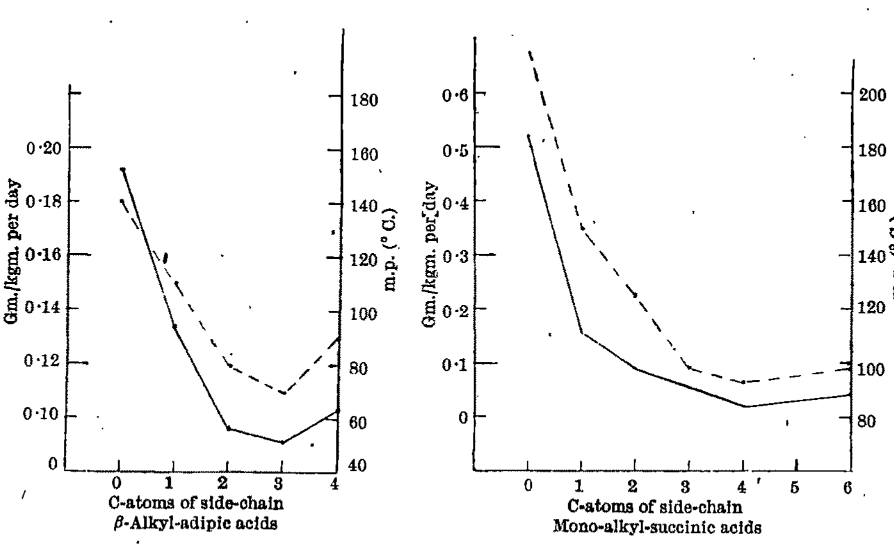
Fig. 2. α-*n*-Alkyl-stearic acids. Melting points

Branched-chain fatty acids used

Main-chain		M.p.
C_{18}	α-Methyl-stearic acid	54°
C_{18}	β-Methyl-stearic acid	49°
C_{18}	γ-Methyl-stearic acid	50·5°
C_{19}	β-Methyl-nonadecanic acid	48°
C_{18}	α-γ-Dimethyl-stearic acid	39°
C_{17}	α-β-Dimethyl-margaric acid	43°
C_{18}	α-Ethyl-stearic acid	48°
C_{16}	3,7,11,15-Tetramethyl-palmitic acid (= phytanic acid)	liquid at room temp.
C_{12}	α-Methyl-dodecanic acid	,, ,, ,, ,,
C_{12}	3,7,11-Trimethyl-dodecanic acid	,, ,, ,, ,,

We studied the behaviour of all acids in the same two dogs, *S* and *T*; our results are shown in Fig. 4.

Each dog was fed in each experiment with the same amount, namely, 25 gm., of the respective acid at the beginning of the first day. The urines of the first and the following three days were collected separately, acidified and extracted with ether; the extracts were separated as steam volatiles containing mainly monobasic acids, and as ether solubles, but not as steam volatiles containing mainly dibasic acids. In Fig. 4 the height of the columns indicates milli-equivalents acid in the total urine for four days; the blank values over the same space of time lie between 4·0 and 6·4 milli-equivalents. It is seen that monomethylated acids are freely oxidized, no residues appearing in the respective urines. The same is the case with repeated methylated acids; from which it may be anticipated that the methyl groups are not in the α-β-position, but farther apart, in the α-, γ, or α-, δ-positions. If that is so, as in phytanic acid, the even 4 methyl groups in one molecule are totally tolerated. Ethyl in the α-position hinders the oxidation, but only partially. We fed 25 gm., or 76·4 milli-equivalents, of it, and obtained only 4–6 milli-equivalents residues, or 5–8 per cent. Two neighbouring methyl groups in the α-, β-position hinder the oxidation considerably more, as already said, but not completely: from 76·4 milli-equivalents, or 12 per cent,



C-atoms of side-chain
β-Alkyl-adipic acids

C-atoms of side-chain
Mono-alkyl-succinic acids

Fig. 1. Melting points and tolerance

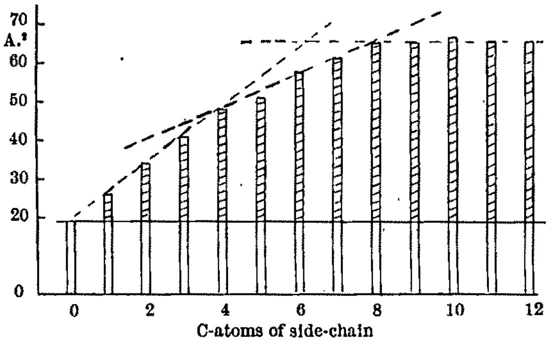
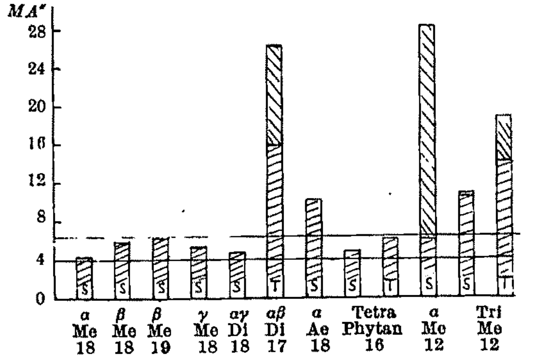


Fig. 3. α-n-Alkyl-stearic acids. Minimal areas

in the non-volatile fraction, and in addition the same level in the volatile fraction.

We found, further, that the totally consumed main-chain must be composed of at least sixteen carbon atoms or more; shorter chains, as in dodecanic acid, will not be oxidized so freely; one methyl alone attached to C-atom 2 hindered oxidation more than three methyl groups in the 3, 7, 11-positions to the carboxyl. We believe that the higher acids form better solid films in the lipids of the cell than they do spread out on a water-air interface. Equally they are held more firmly by the oxidative enzymes, and therefore they are better tolerated in the body.



4–6, 4 *MA″* = Normal excretion, 4 days.
Upwards shading = Ether solubles, not steam-volatile acids
Downwards shading = Ether solubles, and steam-volatile acids.

Fig. 4. Methylated fatty acids. Dogs *S* and *T*, 25 gm./4 days

We wish to thank Dr. Imhausen and Co., Witten/Ruhr, also L. Hoffmann La Roche and Ciba, Basle, for their assistance. A detailed report of this work will be published later in *Hoppe-Seyler's Zeitschrift für physiologische Chemie.*

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Biological Deacetylation of Acetamido Compounds and Formation of Benzoxazolone

IN a recent paper, Smith and Williams[1] discuss the fact observed by Jaffé and Hilbert[2] that acetanilide is hydroxylated by the dog mainly in the *ortho* position and by the rabbit only in the *para* position. They postulate that this difference may be due to the different degrees of deacetylation which take place in the two animals. The dog is known to be much less efficient than the rabbit in acetylating the aromatic amino group[3,4], although it is able to acetylate aliphatic amino groups, as in the formation of mercapturic acids[5]. The deacetylation of acetanilide in the dog does not appear to have been reported upon but we have observed, in agreement with Smith and Williams, that the rabbit deacetylates it to only a slight extent (not more than 2–3 per cent). The deacetylation of acetylsulphamezathine by the dog and rabbit has been studied by Krebs, Sykes and Bartley[6], who found that the former deacetylates about 29 per cent of an injected dose whereas the latter deacetylates only 1 per cent in the same time. It would therefore be expected that considerable deacetylation of acetanilide would occur in the dog.

The preliminary results of an investigation in progress in this laboratory have an indirect bearing on this problem. Jaffé and Hilbert reported the isolation of benzoxazolone as a metabolite of acetanilide in the dog, but not in the rabbit; and although it has frequently been suggested that this was an artefact, so far as we are aware no clear experimental evidence to this effect has been presented. We have now shown that if normal rabbit urine to which *o*-aminophenol has been added is treated by the procedure used by Jaffé and Hilbert (namely, evaporation to dryness, extraction of the residue with alcohol and treatment of the alcohol-soluble material with boiling 2*N* hydrochloric acid, followed by extraction with ether) benzoxazolone can be isolated as its monohydrate (m.p. 95°). This was characterized as its benzoate, m.p. 171°. If, however, *o*-acetamidophenol is used instead, benzoxazolone cannot be detected. This result, therefore, suggests that if no deacetylation of acetanilide occurred in the dog, the procedure employed by Jaffé and Hilbert would not have resulted in the formation of benzoxazolone, which appears to take place during the preliminary evaporation of the urine.

We are also engaged upon a study of the deacetylation process *in vitro*. This has shown that dog liver is much more active in deacetylating acetanilide than is rabbit liver, the average percentages hydrolysis in twenty hours under comparable conditions being 76 and 26 respectively. Although the exact relationship between *in vitro* and *in vivo* deacetylation cannot be assessed, it is probable that our *in vitro* results reflect the process in the intact animal. Our experiments have, moreover, provided evidence for the existence of different deacetylases for aliphatic and aromatic acetamido compounds. Dog liver deacetylates acetanilide readily (76 per cent in twenty hours) but acetylglycine only slightly (11 per cent in the same time). With rabbit liver, however, the converse is true, acetanilide being hydrolysed to an extent of 18 per cent in twenty hours and acetylglycine 98 per cent. In this tissue, drying by acetone results in the destruction of the 'aromatic' deacetylase whereas the 'aliphatic' deacetylase activity is unimpaired. These results may be interpreted as lending support to the suggestion put forward by Stekol[5], which has been substantiated by the results of work by Bloch and Rittenberg[7], that the biological processes for acetylating aliphatic and aromatic amines are separate processes.

A fuller report of this investigation is in preparation for publication.

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Role of Hydroxylamine in Biological Fixation of Nitrogen

The position of hydroxylamine as an intermediate in the nitrogen fixation process has become increasingly doubtful as a result of recent studies[1,2]. No direct attempts have been made, however, to find the effect of hydroxylamine on nitrogen fixation. An application of the isotope tracer method to this problem is being made in these laboratories, using nitrogen containing 30 per cent nitrogen-15. A large 18-hour-old culture of *Azotobacter vinelandii* in a nitrogen-free mannitol medium was aseptically subdivided into equal 100-ml. portions, and 1 ml. of suitable dilutions of buffered hydroxylamine added to give the concentrations required for inhibition measurements. The cultures were then aerated in parallel with an atmosphere containing nitrogen (partial pressure, 0·25 atm.), and oxygen (partial pressure, 0·2 atm.)—the nitrogen being 'heavy'—in a thermostat at 29° C. After a four-hour period of aeration, the cells were collected, and nitrogen samples prepared for isotope analysis. The following analyses were obtained:

$[NH_2OH]$	0	10^{-4} *M*	10^{-3} *M*	10^{-2} *M*.
% N^{15} excess over normal	1·14	0·427	0·003	0·001

This represents 63 per cent inhibition of nitrogen uptake at 10^{-4} *M*, and virtually 100 per cent inhibition at 10^{-3} *M* and higher. Hydroxylamine is well known to be a powerful respiratory inhibitor[3], and since nitrogen fixation is an endothermic process, it should be inhibited also[1]. If hydroxylamine is an intermediate in the fixation process, it can be expected to replace molecular nitrogen in the metabolism of the bacteria, and this effect will, therefore, be reflected in greater inhibition of nitrogen fixation than respiration, for a given concentration of hydroxylamine. A provisional comparison may be made with the results of respiration experiments of other workers. Wilson and Wilson[3] report 90–100 per cent inhibition at 10^{-3} *M*, and 90 per cent at 10^{-4} *M*, with *Azotobacter vinelandii* in a succinate medium. Endres[4] reports approximately 60 per cent inhibition at 10^{-4} *M*, and 90 per cent at 10^{-3}, with *Azotobacter chroococcum* in a glucose medium. The inhibition of nitrogen fixation, therefore, does not appear to be greater than the inhibition of respiration, although a final comparison cannot be made until experiments designed to permit this, and proceeding here, have been completed with the strain of *Azotobacter* available.

Parallel experiments are being made to find the effect of hydroxylamine on the growth of *Azotobacter* on gaseous nitrogen. The organisms were cultured in various concentrations of hydroxylamine, and growth measured by direct counting. Growth was supported indefinitely in a solution of initial concentration 10^{-4} *M*, for one subculture only at 10^{-3} *M*, and not at all at 10^{-2} *M*. Long lag phases were observed, however, growth being apparently delayed until the concentration of hydroxylamine had decreased to less than 5×10^{-5} *M* in the first subculture, which agrees with the observations of Novak and Wilson[2]. The lag increased from a few hours in the first subculture at 10^{-4} *M*, to three days at the sixth. Further experiments, which are being continued, indicate that the rate of removal of hydroxylamine from a culture medium is independent of the presence of the bacteria, even with six previous subcultures at 10^{-4} *M* (comparing with Lewis and Hinshelwood's observations[5]). Experiments here have shown that the levels of ammonia in culture solutions of *Azotobacter* supplied with hydroxylamine were higher than those not similarly supplied. This, together with the above observations on the rates of removal of hydroxylamine from such solution, suggests the liberation of nitrogenous materials from the cells in the presence of hydroxylamine, rather than the reduction of the latter, as postulated for the symbiotic system by Virtanen[6]. The liberation of nitrogenous substances was confirmed by Kjeldahl analyses.

The results of these studies support those from the isotope-tracing experiment above in suggesting that hydroxylamine is unlikely to be one of the stable intermediates of nitrogen fixation by *Azotobacter*.

The isotope abundance measurements were made by one of us (E. R. S. W.) on a Nier-type, 60° sector mass spectrometer, with electronic circuits described by Graham *et al.*[7]. We wish to express our indebtedness to Dr. S. E. Jacobs for his continued interest and advice.

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Effect of *p*H on the Activity of some Respiratory Inhibitors

Changes of *p*H have been shown to influence the activity of certain respiratory inhibitors, for example, iodoacetate[1], azide[2], fluoride[3] and malonate[4]. We have been led to a detailed investigation of the effects of *p*H change on some of these inhibitors since they are all the salts of weak acids, and one of us (E. W. S.) has recently examined the influence of *p*H on the fungistatic action of weak acids allied to phenol[5].

The Warburg manometric technique was used to measure the rates of oxygen uptake by suspensions of

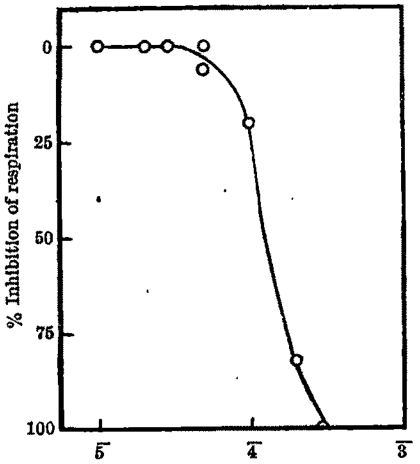

Fig. 1. Inhibition of yeast respiration by sodium iodoacetate at *p*H 4·8

baker's yeast in *M*/15 phosphate buffers containing *M*/5 glucose. In a typical experiment, each vessel contained 2 ml. 0·5 per cent yeast suspension at one *p*H level (measured colorimetrically) and 0·5 ml. of the respiratory inhibitor at the desired concentration. The experiments with sodium iodoacetate were carried out at 30° C. and the (constant) rates of oxygen uptake were measured after twenty-one hours.

Fig. 1 shows the effect of increasing concentrations of iodoacetate on the respiration-rate of yeast at *p*H 4·8. Concentrations below 5×10^{-5} *M* have no inhibiting effect, but at higher values the curve falls sharply and at 3×10^{-4} *M* inhibition is complete. We have obtained equally steep sigmoid curves from experiments at various *p*H values between 2·3 and 7·8. To find the effect of change of *p*H on the activity of the inhibitor, we have determined the concentration of inhibitor required to give 50 per cent reduction of the respiration-rate at several *p*H-levels. From Fig. 1 it can be seen that the concentration required to halve the respiration-rate at *p*H 4·8 is $1 \cdot 3 \times 10^{-4}$ *M*. The logarithm of this value and of the corresponding equi-effective concentrations at other *p*H-levels are plotted against *p*H as the continuous line in Fig. 2. It is evident that greater concentrations of iodoacetate are needed to halve the respiration-rate at the higher *p*H levels. Thus at *p*H 3·5 the necessary concentration is 3×10^{-5} *M*, but at *p*H 7·5 the concentration needed to produce the same effect is one hundred times greater (3×10^{-3} *M*). It is therefore possible to find a concentration of inhibitor which will have no effect on respiration at one *p*H and yet will inhibit it completely at a lower *p*H.

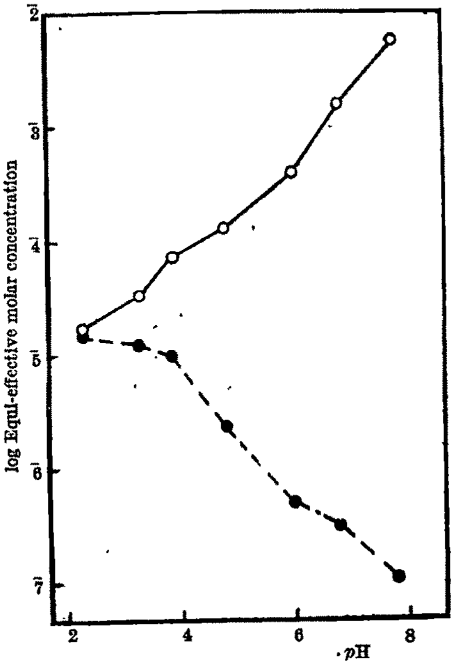

Fig. 2. Effect of *p*H on the concentration of sodium iodoacetate required to inhibit yeast respiration by 50 per cent. Full line, total concentration (A + HA); broken line, concentration of undissociated molecules (HA)

Iodoacetic acid is a weak acid with a *p*K of 3·1, and for any given concentration the amount of undissociated acid in the solution will decrease rapidly as the solution is made more alkaline according to the equation

$$pH = pK + \log \frac{[\text{dissociated acid, } (A')]}{[\text{undissociated, } (HA)]}.$$

To test the hypothesis that HA is the only active inhibiting agent[2,3], the amounts of HA at the equi-effective concentrations have been calculated and plotted for each *p*H (Fig. 2). It is seen that the concentration of HA does not remain the same (as it would if HA alone were active) but decreases at the higher *p*H-levels. The same is true for the effect of *p*H on the toxicity of many weak acids to a wide variety of plant and animal organisms[5]. The concentration of HA in the external solution is an important factor in determining the extent of inhibition, but it is clearly not the only one. The relationships shown in Fig. 2 have been interpreted[5] on the supposition that only HA penetrates into the cell but that local *p*H conditions inside the cell also determine the response by their influence on the extent of dissociation of the acid within the cell.

Experiments on the effect of sodium azide on yeast respiration have yielded curves similar to Figs. 1 and 2.

Our results emphasize the importance of control of *p*H during *in vivo* studies with inhibitors which are weak acids. The possibility is being examined that *p*H changes induced by carbon dioxide when yeast is fermenting in nitrogen in a closed Warburg vessel are instrumental in bringing about a form of the Lundsgaard 'differentiating' effect of iodoacetate[6]. We have, in fact, already shown that the inhibition of fermentation brought about by 10^{-3} *M* iodoacetate (which has no effect on respiration at the same initial *p*H—6·8) can be prevented if the carbon dioxide produced during treatment with the inhibitor is absorbed by potassium hydroxide.

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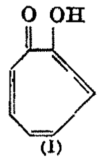
Synthesis of 3 : 4-Benztropolone

DEWAR[1] has interpreted the chemistry of the mould metabolite, stipitatic acid, and of colchiceine (the methyl ether of which is the alkaloid colchicine) by postulating that they are derived from the hypothetical *cyclo*heptatrienolone (I). This he termed 'tropolone', and he attributed to it quasi-aromatic character. This interesting suggestion, for which no tangible evidence was advanced[2], has acquired more plausibility from the recent demonstration of Haworth, Moore and Pauson[3] that purpurogallin is a trihydroxybenztropolone, as earlier suggested by Barltrop and Nicholson[4], and from the finding of Erdtman and Gripenberg[5] that the cedar-wood constituent γ-thujaplicin is an *iso*propyltropolone. Hitherto, a synthetic tropolone of established constitution has not been prepared, and the properties ascribed to such a structure have been based largely on speculation.

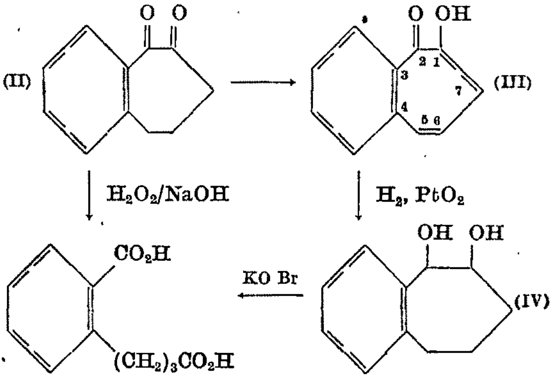
We have now synthesized one of the two possible benztropolones, namely, 3 : 4-benztropolone (III), and have made a preliminary survey of its properties. 2 : 3-Benz-1-suberone[6] was oxidized by selenium dioxide in boiling ethanol to 3 : 4-benzsuberan-1 : 2-dione (II), a deep yellow liquid, b.p. 128–132°/0·4 mm., which gave a mono-2 : 4-dinitrophenylhydrazone, m.p. 230–232° (found: C, 57·5; H, 3·95; N, 15·8. $C_{17}H_{14}O_5N_4$ requires C, 57·6; H, 4·0; N, 15·8 per cent) and a semicarbazone, m.p. 190–192°. The diketone (II) was dehydrogenated to 3 : 4-benztropolone (III) by bromine in acetic acid at 100°. The tropolone, obtained by this method in small yield, crystallized from *cyclo*hexane in pale yellow needles, m.p. 85–86° (found: C, 76·3, 77·0; H, 4·7, 4·6. *M* (Rast), 186. $C_{11}H_8O_2$ requires C, 76·7; H, 4·7 per cent. *M*, 172). Better results were obtained when the dehydrogenation was effected with 10 per cent palladized charcoal in boiling trichlorobenzene, under nitrogen (5 hours). The benztropolone was isolated in 10 per cent yield from the fraction of the products soluble in dilute sodium hydroxide solution. Two other products, not yet investigated, were also isolated. After the crude trichlorobenzene solution was diluted with benzene, shaking with sodium bicarbonate solution extracted a small amount of a compound which, after reprecipitation with acid, crystallized from light petroleum in yellow needles, m.p. 128–130°. Addition of sodium hydroxide solution to the benzene-trichlorobenzene liquors gave a buff-coloured neutral crystalline solid, m.p. 265–268°, the benztropolone being afterwards liberated by acidification of the alkaline liquors.

Benztropolone, of which purpurogallin is a trihydroxy derivative, had in most respects the chemical properties which would be expected from its structure and from the behaviour of natural products thought to be tropolone derivatives. Although, unexpectedly, not sufficiently acidic to undergo salt formation with sodium bicarbonate, it dissolved readily in sodium hydroxide solution. By fusion with 80 per cent potash at 180–185°, it was almost quantitatively converted into α-naphthoic acid.

The presence of a seven-membered ring, indicated by the method of synthesis, was confirmed by hydrogenation of benztropolone over Adams's catalyst to the diol (IV), which gave a yellow-green colour with Criegee's potassium tetramethylosmate reagent[7], was unaffected by alkaline hydrogen peroxide, but was oxidized by potassium hypobromite to γ-2-carboxyphenylbutyric acid (V), obtained also by oxidation of benzsuberone with 2 per cent nitric acid[8]. Benztropolone showed no carbonyl reactivity, but was hydrogenated over palladized charcoal to a resinous product which gave an immediate precipitate with 2 : 4-dinitrophenylhydrazine and was oxidized by alkaline hydrogen peroxide to the acid (V), as also was benzsuberandione (II). Microhydrogenation of benztropolone using palladium-black led to absorption of three molecules of hydrogen. Haworth, Moore and Pauson[3] recorded a similar behaviour in the hydrogenation of a methyltropolone, which they prepared by degradation of purpurogallin.



(I)



Benztropolone gave a brownish-red colour with ferric chloride, and dissolved in concentrated hydrochloric acid to a bright yellow solution. On dilution, the colour was destroyed and the benztropolone was precipitated. Benztropolone coupled with *p*-tolyldiazonium chloride to give a crimson precipitate.

Details of this work, which is being extended, will be published elsewhere.

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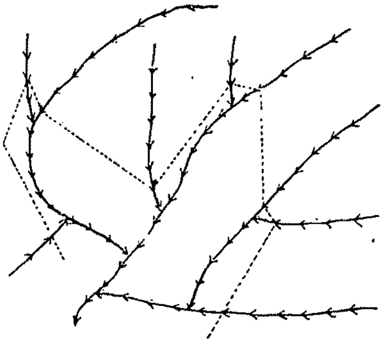
Amylopectin and Glycogen: Products of Irreversible and Reversible Synthesis

IT is assumed that the molecules of amylopectin and glycogen have a ramified structure, the glucose residues being united by α-glucosidic 1,4- or 1,6-linkages, the latter representing the branching points. By β, the 'degree of ramification', we shall denote the ratio between the number of 1,6-linkages and the total number of glucose residues. For amylopectin, β ~ 0·056; for glycogen, β ~ 0·09.

The biological synthesis of the polysaccharides is effected by two phosphorylases, one synthesizing 1,4-linkages, the other 1,6-linkages, the starting material being in both cases glucose-1-phosphate[1,2]. The first enzyme, studied by Hanes and others, when acting alone, synthesizes unbranched saccharides of the amylose type. This enzyme is called the '*P*-enzyme' by Haworth. Bernfeld, Meyer and their co-workers use the designation 'phosphorylase', whereas the enzyme synthesizing 1,6-linkages is termed 'isophosphorylase'. This enzyme seems, on the whole, to be identical with the '*Q*-enzyme' of Haworth and the 'branching factor' of Cori.



Part of a ramified molecule of the amylopectin–glycogen type. Parts outside dotted line are split off as maltose by β-amylase

When a polysaccharide is formed through the simultaneous action of both enzymes, one may imagine two extreme cases: one which has been emphasized by Bernfeld[3], Meyer[4] *et al.* is that of *reversible* synthesis, when the macromolecule is in contact with the enzymes for so long a time that its final state is one of equilibrium; the other extreme is a completely *irreversible* synthesis, where the growth of the molecules is so rapid that the reverse reaction is negligible.

We believe it possible to decide which of these two possibilities is most closely approached by studying the action of β-amylase on the macromolecules. This enzyme attacks only end chains, splitting off glucose units in pairs as maltose[5]. Now the fraction of the total number of glucose residues that can be split off by β-amylase is a quantity characteristic of the polysaccharide and can be experimentally determined; we shall denote it as ζ.

A few years ago[6], we derived a relation between ζ and β that should hold for the case of irreversible synthesis, supposing that the β-amylase cuts off as much as possible from the end chains without breaking any 1,6-links:

$$\zeta_{2(\mathrm{irr})} = 0\cdot 6557 - 1\cdot 4371\,\beta + 0\cdot 3151\,\beta^2 + 0\cdot 3154\,\beta^3 + \ldots \qquad (1)$$

Now we have derived the corresponding formula for the case of a macromolecule in its equilibrium state (reversible synthesis):

$$\zeta_{2(\mathrm{rev.})} = 0\cdot 5 - 1\cdot 25\,\beta + 0\cdot 625\,\beta^2 + 0\cdot 3125\,\beta^3 + \ldots \qquad (2)$$

In both cases it has been assumed that there is no serious steric hindrance, so the probabilities for the formation (or breaking) of 1,4- and 1,6-links have the same ratio in all parts of the molecule.

If these formulæ are applied to amylopectin with $\beta = 0\cdot 065$ we find $\zeta_{2(\mathrm{irr.})} = 0\cdot 58$ and $\zeta_{2(\mathrm{rev.})} = 0\cdot 43$, whereas the experimental values range between 0·55 and 0·62. On the other hand, for glycogen with $\beta = 0\cdot 09$ we find $\zeta_{2(\mathrm{irr.})} = 0\cdot 53$ and $\zeta_{2(\mathrm{rev.})} = 0\cdot 39$, whereas $\zeta_{\mathrm{exp}} = 0\cdot 35$–$0\cdot 45$. (A higher value which was occasionally found by Meyer may be due to degradation because of the rough pretreatment of the sample.)

Thus it appears that amylopectin is certainly not in an equilibrium state of the type assumed by Bernfeld and Meyer, although this might be approximately true for glycogen. Starch seems to be formed chiefly by a one-way process and is stored in the plant for a long time, whereas glycogen is formed as a reserve for short times of delivery and is continuously changing its amount in the animal (and yeast) organisms.

It seems possible that, under certain conditions, the organisms can form glycogen so rapidly that there is no time for equilibrium. In such samples of glycogen, the relation between β and ζ would deviate from (2) and tend toward (1).

Details of these calculations will be published in *Acta Chemica Scandinavica*.

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Cephalopods from Local Waters at the University of Istanbul

Through the kindly co-operation of the British Council, I have been enabled to examine the local collection of Cephalopods of the University of Istanbul, which was sent to me by Prof. Curt Kosswig, of the University's Zoological Department.

It comprises eleven specimens, preserved in formalin solution:

Name	Overall length
Eledone moschata (Lamarck)	34 cm. 33 ,, 19 ,,
* *Sepietta neglecta ?* (Naef)	101 mm. 93 ,,
Sepia elegans (Orbigny)	158 mm.
Alloteuthis media (Linné)	205 mm. 185 ,, 181 ,, 179 ,,
† *Octopodoteuthis sicula* (Rüppell)	133 mm.

* Probably *S. neglecta*.

† Both fins had had about a third of the area farthest from the body cut off.

Of these five species, my regional records of the distribution of Cephalopods mention, as having been encountered in this region, only *Octopodoteuthis sicula* (Rüppell); locality, east of Rhodes.

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Sept. 11.

NEW OPTICAL GLASSES

By R. KINGSLAKE and P. F. DePAOLIS
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BEFORE 1880 the only types of optical glass available to lens designers were the flint-crown series, in which the addition of progressively increasing amounts of lead oxide led to a progressive increase in both refractive index and dispersive power, so that in effect there was a fixed relation between the dispersive power and refractive index of all available glasses (Fig. 1).

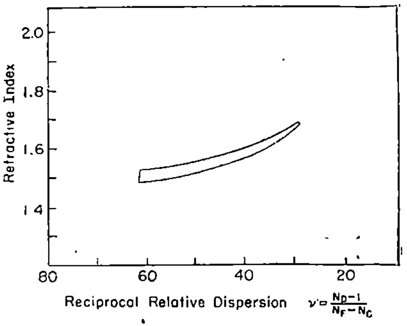

Fig. 1. Optical glasses (prior to 1880)

In order to achromatize any lens, the positive elements must be of lower dispersive power than the negative elements, and in those days this meant that the refractive index of the positive elements had to be low, and that of the negative elements high. This had two very adverse effects: on one hand, it tended to make the Petzval sum large, giving a strongly inward-curving field; and, on the other hand, it made the surfaces of the positive elements strong and those of the negative elements relatively weak. As the lens on the whole is positive, this resulted in considerable amounts of zonal spherical aberration, and also indirectly in large residuals of all the other aberrations.

For two reasons, then, a crown glass was needed with low dispersion and high refractive index, and also, if possible, a flint glass of high dispersion and low refractive index. The invention of barium crown glass in the 1880's by Abbe and Schott helped greatly to meet the first requirement, but the problem of the low-index flint was not solved at that time. (Incidentally, plastics, crystals and liquids mostly tend to have higher dispersion for their index than glasses, but these materials are generally undesirable for other reasons.)

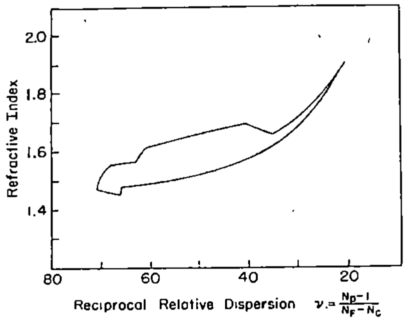

Fig. 2. Optical glasses (prior to 1934)

With the introduction of barium crown glass, many new types of photographic lens became possible, the first to be developed being cemented triplets of the 'Dagor' type, in which the three glasses are common crown, light flint, and dense barium crown in that order. Barium crown glass also greatly improved all lenses of the air-spaced type (the Cooke triplet and the 'Celor', for example) by weakening the surfaces of the crown elements and enabling the designer to shorten the lens without adversely affecting the Petzval sum. To be sure, some successful lenses of the meniscus type, for example, the 'Omnar', were designed without using barium crown; but these were the exceptions, and they did not become very popular.

The refractive index of barium crown glasses was raised slowly and steadily by Schott until the early 1930's (Fig. 2). At that time they introduced *SK*-16 and *SK*-18, which marked the upper limit of the ordinary barium–soda–lime silica types. These glasses are chemically unstable and present difficulties in lens manufacture because of their susceptibility to acid staining, and because of their brittleness.

Following the First World War, G. W. Morey, who had done work of great value in connexion with the production of optical glass for military purposes, discussed the advances which could be made in optical glasses with C. W. Frederick, chief of the lens designing bureau of the Eastman Kodak Company. Frederick suggested that what was wanted was a very high refractive index with low dispersive power and that even a small production on a laboratory scale would be useful. Morey undertook to study the optical properties of glasses in relation to chemical composition especially with a view to the production of high refractive index crown glasses. To this end all high atomic-number cations were chosen for systematic study in silicate, borate and phosphate glasses. Small melts of twenty to forty grams were made to indicate the field of glass formation. The more promising ones were repeated in larger melts of fifty to one hundred grams.

By 1933, the work had progressed to the point where silicon and phosphorus were discarded as glass-forming elements. Boric oxide had by now proved to be by far the best fluxing agent. Oxides of elements such as lanthanum and thorium found in the rare earths, and columbium, tantalum, tungsten, titanium, zirconium and strontium were used in major portions up to 80 per cent by weight, with or without the usual barium, zinc, magnesium and aluminium.

In 1934, samples of unusual glasses with characteristics n_D in the region of 1·85 and ν, the reciprocal relative dispersion, of 47·0 were in existence, and their properties well measured. About this time the work was expanded to a larger scale by the Kodak Research Laboratories. Under the direction of S. E. Sheppard, L. W. Eberlin and P. F. DePaolis made a systematic study of the solubility of the rare elements in boric acid and the limits of glass formation. The results of the combined work were revealed in patents by Morey[1] and by Eberlin and DePaolis[2].

Lanthanum is very soluble in boric acid, and its contribution to higher refractivity without increase of dispersion is remarkable. The oxides of tantalum, thorium and tungsten are soluble in the lanthanum borate base glass in amounts up to 35 per cent. These new borate glasses are very stable and fairly hard. They are harder than flints, suitably stable to the atmosphere, and amenable to optical shop practices of moulding, grinding and polishing.

Early in the development work it was found that the new rare-element borate glasses were extremely corrosive to all known pot refractories. A decision was therefore made to use platinum for the actual production of these glasses. This was justified on the basis that no platinum would be lost by contamination, and that the glass, once homogenized, could be poured in its entirety, free from striæ, into a single slab or into cast shapes without striæ, seed, bubbles or other defects usually attending a glass made in a refractory pot.

The first of the new glasses to be made had a refractive index of 1·7445 and a reciprocal relative dispersion of 45·8. The glass was slightly yellow, but further work established the origin of the yellow colour, and finally glasses were produced as colourless and homogeneous as any other ordinary optical glass.

Pilot-plant operation began in September 1937, and the first commercial glass was delivered in June 1939. Production increased rapidly, and more than 125,000 lb. of rare-element glass were produced during the Second World War (1942–45). Much of the success of the enterprise was due not only to the platinum equipment but also to the Kodak method of using all-electric heating and a small-pot, 'multi-pot–multi-stage' process.

Under sustained production conditions during the War, the yield of finished usable glass in a cast form was 95 per cent of the theoretical glass available in the batch.

Electric heating was retained in a plant that was erected during the War and operated from December 1942 to September 1945 on a continuous basis of approximately 5,000 lb. of finished glass a month. The process consisted of feeding thirty-two 10-lb. platinum-lined pots every twenty-four hours, starting one every three-quarters of an hour, and progressively moving these pots through the various stages of the glass-making process.

Since 1940 the types of these glasses in production have been extended, and at the present time the following seven types are being made:

	n_D	ν		n_D	ν
EK–110	1·69680	56·2	*EK*–330	1·75510	47·2
–210	1·73400	51·2	–450	1·80370	41·8
–310	1·74500	46·4	–448	1·88040	41·1
–320	1·74450	45·8			

All these glasses contain thorium, and in the case of folding cameras, in which the lens may rest for a long time in close proximity to film, the radioactivity of the thorium may be a disadvantage. A thorium-free equivalent of *EK*-320 is available.

The new glasses were first used in lens design in 1934; actual production of lenses began a few years later, and to-day many of the Eastman Kodak 'Ektar' lenses contain the high-index glass. The versatility of these glasses is evidenced by the large number of lens patents which specify such glasses.

After the transfer of the production of the new glasses to the factory, the Kodak Research Laboratories continued their study of optical glasses. Theoretical considerations by M. L. Huggins and K. H. Sun predicted the possibilities of further new glasses, and their predictions have proved correct. Of the glass systems of this type which were worked out by Sun, the most useful were flint glasses containing titanium oxide and using fluorine in addition to silica.

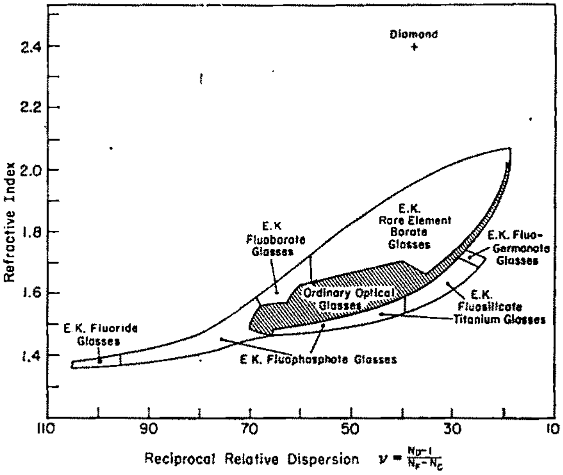

Fig. 3

These unusual glasses lie well below the ordinary flint line (Fig. 3). For a given index, the dispersion is appreciably greater than that of ordinary flints. In this sense the glasses may be termed super-flints. The best glasses lie in the region 45 per cent silica, 28 per cent titanium oxide, 27 per cent sodium fluoride, ranging in optical properties from n_D 1·65/ν29 to n_D 1·58/ν36·6. The glasses can be moulded, are very resistant to tarnish, and are easily fabricated by the usual optical methods.

The fluosilicate flints are almost as useful to the optical designer as the high-index glasses, since they extend the possible difference between crown and flint refractive index and between crown and flint dispersion. With these glasses, three-element lenses have been designed to give even better performance than the usual four-element types. K. H. Sun succeeded in producing novel mixtures in some twenty quite different glass fields, including fluo-borate, fluo-germanate[3] and fluo-phosphate systems.

A most interesting group of glasses suggested by Sun are those containing no oxides and composed entirely of fluorides. These glasses show the characteristic low refractive index and extremely low dispersion previously available only in fluoride minerals. The refractive index in most of the glasses is approximately 1·38–1·39 and the ν-value, 100. Moreover, the glasses are transparent to below 300 mμ in the ultra-violet and to 5 μ in the infra-red, so that they may be very useful in the making of instruments requiring optical transparency over a wide range of wave-lengths. Difficulties have been met in the production of these all-fluoride glasses, but it is possible that these difficulties may be overcome in the near future.

The extension of the frontiers of optical glass by this work is illustrated in Fig. 3. In this figure the range of optical glasses known before 1934 is shown shaded, while the larger area shows the glasses that can be made at the present time.

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[1] British Patent 462,304, March 3, 1937; United States re-issue Patent 21, 175, August 15, 1939.

[2] United States Patents 2,206,081; 2,241,249; 2,434,146; 2,434,147; 2,434,148; 2,434,149. British Patents 462,304; 608,298.

[3] United States Patent 2,425,403.

ACTIVITY COEFFICIENTS IN CONCENTRATED SOLUTIONS CONTAINING SEVERAL ELECTROLYTES

By Dr. E. GLUECKAUF

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In problems connected with concentrated solutions involving several electrolytes, it is necessary to have a knowledge of the activity coefficients of the separate salts. The determination of these activities in mixtures is usually a major experimental difficulty, and it is desirable to have a method for their calculation.

An important step in this direction was made by Guggenheim[1] in 1935, who derived the following equation for the activity coefficient $f^{\overset{X_1Y_1}{(X_2Y_2)}}$ of an electrolyte X_1Y_1, in the presence of another electrolyte X_2Y_2 (in different notation)

$$\log_{10} f^{\overset{X_1Y_1}{(X_2Y_2)}} = \frac{-0{\cdot}5\, x_1y_1}{(1 + I^{-1/2})} + \frac{x_1}{x_1 + y_1} \sum_X \lambda_{XY_1}[X] + \frac{y_1}{x_1 + y_1} \sum_Y \lambda_{X_1Y}[Y], \qquad (1)$$

where x and y are the ionic charges of X and Y, taken positive irrespective of sign, $[X]$, $[Y]$ are the molar concentrations of the ions, I is ionic strength $= \frac{1}{2}\Sigma(x^2[X] + y^2[Y])$, and λ_{XY} are constants. The subscripts 1 and 2 refer to the solutes X_1Y_1 and X_2Y_2, respectively.

As shown by Guggenheim, this equation with a suitable choice of constants gives excellent agreement with the observations up to an ionic strength of about 0·3 mol./l., but does not apply at higher concentrations.

An analysis of the properties of Guggenheim's equation shows that its application is restricted mainly by the assumption that the 'specific' part of the activity coefficient, represented by the λ terms, is linear in the concentrations.

However, if we assume that the λ's are not constant, but are functions of the ionic strength I, then a much wider range of application is possible. We can now eliminate the λ's from the known values of the activity coefficients of the pure solutes at this ionic strength. This leads to a relationship between the activity coefficients in a mixed solution $\left(f^{\overset{X_1Y_1}{(X_2Y_2)}}\right)$ and those of the pure solutes ($f^{X_1Y_1}$, $f^{X_2Y_2}$, etc.) at the total ionic strength I of the solution.

In the most interesting case, that of two ionic solutes with a common ion, we obtain the simple relationship :

$$\log_{10} f^{\overset{X_1Y}{(X_2Y)}} = \log_{10} f^{X_1Y} - \frac{[X_2]}{4I}\left[K_1 \log_{10} f^{X_1Y} - K_2 \log_{10} f^{X_2Y} - \frac{K_3}{(1 + I^{-1/2})}\right], \qquad (2)$$

where $K_1 = x_2(2x_2 - x_1 + y)$, $K_2 = x_1(x_2 + y)^2(x_1 + y)^{-1}$, $K_3 = \frac{1}{2}x_1x_2y(x_1 - x_2)^2(x_1 + y)^{-1}$, which permits the calculation of activity coefficients in mixed solutions if those of the pure solutes are known.

Similar equations can be obtained for solutions in which all the ions are different, and for more than two solutes ; and it should be emphasized that none of these equations contains freely adjustable constants.

Within the limits of the experimental error, equation 2 is obeyed equally well if used with the 'practical' activity coefficients (γ, for use with molalities), instead of the 'rational' ones (*f*, for use with mole-fractions).

The agreement of equation 2 with the experimental data is shown by the example of the activity coefficients of hydrochloric acid for mixtures of 0·01 *M* acid and barium chloride (0·03–3 molar ionic strength), representing the influence of a 2 : 1 electrolyte on the activity of a 1 : 1 electrolyte (see Table 1).

Table 1. Activity coefficients of hydrochloric acid in the presence of barium chloride at 25° C.

Ionic strength (molal) I	$\left[\gamma^{\mathrm{HCl}}_{(\mathrm{BaCl_2})}\right]_{m_{\mathrm{HCl}} = 0{\cdot}01}$		$\gamma\mathrm{HCl}$[2]	$\gamma\mathrm{BaCl_2}$[3]
	Calc. from equation 2	found[4]		
0·03	0·854	0·854	0·855	0·723
0·05	0·823	0·826	0·8304	0·670
0·10	0·782	0·786	0·7964	0·595
0·5	0·708	0·705	0·7571	0·457
1·0	0·698	0·699	0·8090	0·406
2·0	0·743	0·743	1·009	0·385
3·0	0·821	0·823	1·316	0·392

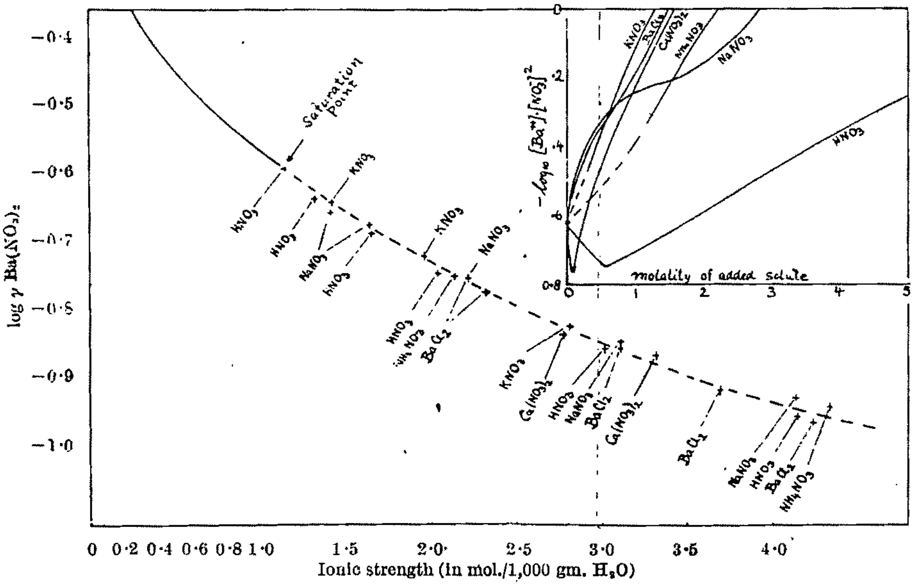
The knowledge of activity coefficients in the presence of multiple solutes renders possible the application of mass-law equations to the solubilities of highly soluble electrolytes. Table 2 shows the constancy of the solubility product of barium chloride in the presence of hydrochloric acid, if use is made of the activity coefficients calculated by equation 2. It speaks for the correctness of the theory that the same solubility product (2·1 ± 0·05) is obtained if sodium chloride is used as a salting-out agent. These examples represent the influence of 1 : 1 electrolytes on the activity of a 2 : 1 salt.

Table 2. Solubility product of barium chloride in the presence of hydrochloric acid

Molalities[5]		$\left(\gamma^{\mathrm{BaCl_2}}_{(\mathrm{HCl})}\right)^3$ calc. from refs. 2, 3	$[\mathrm{Ba^{++}}].[\mathrm{Cl^-}]^2.\gamma^3$
HCl	BaCl$_2$		
—	1·784	0·090	2·0
0·423	1·548	0·108	2·1
0·772	1·366	0·124	2·0
0·890	1·280	0·131	2·0
1·306	1·065	0·153	1·9
1·686	0·846	0·182	1·8
2·078	0·678	0·217	1·7
2·600	0·487	0·286	1·8
3·750	0·205	0·620	2·2
4·410	0·110	0·890	2·1
5·30	0·650	1·620	2·1

Another important application of the theory consists in the use of equation 2 for the calculation of activity coefficients of pure solutes in very greatly supersaturated solutions. After obtaining $\gamma^{\overset{X_1Y}{(X_2Y)}}$ from solubility products in the presence of a second solute, equation 2 can be solved for the activity coefficients of the pure solute (γ^{X_1Y}) at the ionic strengths of the mixed solutions, which are often greater than the saturation strength I of the pure salt X_1Y. As the activity coefficients so obtained must be independent of the nature of the second solute, agreement of the values of γ^{X_1Y} obtained from different combinations of solutes provides a very stringent test for the theory.

The accompanying diagram shows the activity coefficients of supersaturated solutions of pure barium nitrate calculated from its solubility data in the presence of barium chloride, potassium, sodium, calcium and ammonium nitrates, and nitric acid[5], all of which agree perfectly in spite of the greatly differing effect of these solutes on the solubility of barium nitrate. The method is particularly suitable for the calculation of activity coefficients in supersaturated solutions of salts of medium and low solubility, and it promises a considerable extension of our knowledge of activity coefficients by the application of equation (2) to the enormous mass of existing solubility data.



Activity coefficients of pure Ba(NO$_3$)$_2$ in supersaturated solutions calculated from solubilities in the presence of other solutes. Inset: solubility product of Ba(NO$_3$)$_2$ in mixed solutions

This extension of the theory to high concentrations does not, of course, improve other shortcomings which are inherent in the basic assumptions employed in the derivation of Guggenheim's equation, in particular the Brönsted[6] assumption: "that ions are 'specifically' influenced only by ions of opposite sign"; and in a number of cases equation (2) is only very imperfectly obeyed and apparently requires the introduction of an additional term. But in those cases where Brönsted's postulate is fulfilled, the new assumptions lead to equations which fully represent the 'specific' ion effects and cover the whole range up to and beyond the saturation concentrations.

Further details, including applications and critical discussion, will be published in due course.

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[1] Guggenheim, E. A., *Phil. Mag.*, **19**, 606 (1935) (equation 52, symbols changed).

[2] Harned, H. S., and Owen, B. B., "Physical Chemistry of Electrolytic Solutions", table 11-4-1A, p. 547 (1943).

[3] Robinson, R. A., and Stokes, R. H., *Trans. Farad. Soc.*, **36**, 735 (1940).

[4] Harned, H. S., and Geary, C. G., *J. Amer. Chem. Soc.*, **59**, 2032 (1937).

[5] Solubility data from Gmelin's "Handbook" (8th edit.).

[6] Brönsted, T., *J. Amer. Chem. Soc.*, **44**, 877 (1922).

RIVER-FLOW SURVEY AND RECORDS

A GEOPHYSICAL Discussion on the subject of "River-Flow Survey and Records" was held by the Royal Astronomical Society in its rooms at Burlington House, London, W.1, on January 28, 1949, with Sir Roger Hetherington in the chair.

Mr. H. J. F. Gourley opened the discussion. He said that rivers have always played a very important part in the life of the community. In Great Britain the upland tributaries, which are free of contamination, form the chief source of water supply. The larger tributaries and main streams determine the sites of villages and towns and provide the necessary water for industrial development. Thus, quite apart from its scientific interest, an accurate knowledge of river flow is of great importance. The minimum flow is of special significance, for it determines the amount of water available for industrial processes such as cooling, and limits the amount of effluent which may be discharged without excessive contamination. In areas liable to flooding, the maximum flow is also of obvious importance.

The Land Drainage Act of 1930 made no provision for Government grants towards the expenses involved in gauging the flow in British rivers, but the River Boards Act (1947) has now remedied this. It also empowers the Ministry of Health to make recommendations to the various river boards. At present, the Thames is the only river in Great Britain for which day-to-day records exist. In other cases, the Meteorological Office provides good estimates of the rainfall, but lack of knowledge of evaporation and storage makes estimates of run-off somewhat uncertain. They form the principal data from which the engineer can work, and provide a valuable means of obtaining advance information of floods. Nevertheless, they cannot replace accurate gauging, and it is to be hoped that the Ministry of Health will, in future, give every encouragement to this type of work.

Dr. J. Glasspoole, of the Meteorological Office, described how estimates of river flow can be made from rainfall data. Great Britain is remarkably well equipped with rain gauges, and analysis of the records from these has led to a good understanding of the effect of topography on the distribution of rainfall. The actual precipitation over a given basin can usually be determined to within a few per cent, but to derive the run-off in the river requires, in addition, a knowledge of storage and evaporation. Neither is accurately known, but, even so, the correlation coefficient between rainfall and run-off is 0·9, indicating that 80 per cent of the observed fluctuations in river flow can be accounted for by precipitation. To obtain better results there must be close collaboration between meteorology and hydrology. Further information is required on snowfall and its rate of melting. The factors affecting evaporation are very complex, and although considerable work has been done on this problem, it seems unlikely that reliable estimates can be made at present. River flow records are therefore an essential factor, not only for determining the actual run-off but also as a means of finding out about storage and evaporation.

The technical problems involved in gauging the flow of a river were described by Capt. W. N. McClean. When measurements are required, it is seldom practical to construct a special weir or flume, and in these circumstances the best method is to select a stable reach and measure the flow through this with a current meter. Readings must be taken over the whole cross-section area and integrated to give the total flow. Means of locating the current meter quickly and accurately are of great practical importance, and some details were given of a suitable cableway which could be stretched across the river and from which the meter could be lowered at any selected point to the required depth. Measurements of flow have been made for several rivers in Scotland, and fifteen years of continuous records for five of these have been published in tabular form by Capt. McClean. But much more work is required. Water is a very valuable asset, more valuable even than coal, and yet there is no Inland Water Survey in Great Britain. Recent flood damage on the main railway line north of Berwick might well have been averted had there been adequate rainfall and run-off data available to the engineers who designed the line. The silting up of estuaries and the design of hydro-electric schemes are also problems for which river flow records are essential. There is a great need for an organised survey, calling for close co-operation between the Ministry of Health, the Ordnance Survey, the Meteorological Office, the Ministry of Agriculture and Fisheries, and the various river boards and water supply authorities.

Mr. W. Allard, of the Ministry of Health, explained how it is that in the past so little attention has been given in Great Britain to river flow recording. Water supplies are abundant, and there has been no difficulty in meeting the small requirements. In the case of the Thames, very complete data exist; records of the flow at Teddington weir go back as far as 1883. In due course, no doubt, the various river boards will put forward their own suggestions for surveys. Both graphical and tabular methods of recording river flow were considered by Mr. Allard, and it was shown how such data could be used to predict floods and to estimate the changes in flow which would result from a given precipitation.

A lively discussion followed in which all agreed that a more complete survey of river flow is most desirable. Mr. E. Gold pointed out that the average flow gave little useful information and that it was important to know the fluctuations. The Zambesi Falls were given as an example. Here the average annual ratio of maximum to minimum run-off is about 30 to 1, which makes the falls almost useless as a source of hydro-electric power. There were, however, considerable differences of opinion as to the best method of making the measurements. Mr. R. V. Stock, of the Thames Conservancy, described the system of weirs in use at Teddington and explained how it was intended to extend and improve them, to obtain greater accuracy especially at times of minimum flow. Sir Claud Inglis stated that weirs and throated flumes gave the best accuracy, but Capt. McClean maintained that the propeller type of current meter could give excellent results, and, further, could be used on any stable reach of a river without the need for special constructional work. Mr. J. F. Francis, however, doubted if the latter could provide measurements accurate to better than a few per cent; for very low rates of flow, propeller gauges are not reliable.

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE twenty-first annual report of the Council for Scientific and Industrial Research*, Commonwealth of Australia, covering the year ended June 30, 1947, states that consideration was being given to the establishment of two divisions for textile research, one for fundamental work on the chemistry and physics of the wool fibre, and the other to concentrate on the technology of the spinning and utilization of wool. It was hoped at an early stage to commence some work on the degreasing of wool with hydrocarbon solvents as distinct from the normal soap and water scours, and that university research workers will be encouraged to study the fundamental structure and properties of the wool fibre. Other new developments include the appointment of an officer to take charge of the Meteorological Physics Section, where work for a few years will centre on the detailed examination of the atmospheric conditions over a small area. Arrangements have also been made by the Council for a small co-operative section of metallurgy to be accommodated at the University of Melbourne. The initial programme of work will include studies of the properties of metals at high temperatures, the preparation of metal compacts from metal powders and the application of X-rays to studies of metals and alloys. A small team of engineers and chemists has been collected to study the utilization of atomic energy for industrial purposes; this team will work at Harwell, England, and arrangements have also been made for a co-operative programme of research in nuclear physics at the University of Melbourne. A Tracer Element Research Committee has been appointed to advise the Council in work with radioactive isotopes.

Reports have indicated that much of the trouble existing in Australian coal mines could be alleviated by applying established methods of dust prevention, and it has also been recommended that a more detailed survey should be made of the conditions in the mines and into the best means of measuring dust concentrations; and as a result of the visit of the late Prof. T. David Jones, the Council has established a Coal Dust Research Advisory Committee to advise on a programme of research. Attention was also given to the scientific aspects of plans for the Australian Expedition to the Antarctic during 1947–48. The Expedition was expected to pay particular attention to geophysical problems, including meteorology, the earth's magnetism, cosmic rays and, possibly, radio propagation. The scheme for overseas training is now in full operation, and twenty-five officers were abroad during 1946–47. Special emphasis is also laid in the report on the increasing help given to the Council by the universities.

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* Commonwealth of Australia. Twenty-first Annual Report of the Council for Scientific and Industrial Research for the year ended 30th June, 1947. Pp. 139. (Canberra: Commonwealth Government Printer, 1948.) 6s.

The work of the Division of Plant Industry has continued on similar lines to those described in the previous report. Work on weeds has now been divided into two sub-sections—physiology and ecology. The former is concerned with the physiology and biochemistry of plants as related to the penetration and translocation of plant poisons and with the development of more efficient herbicides. The ecology sub-section is concerned with the determination of the ecological factors pertaining to the invasion and establishment of weeds, particularly in grassland, including the testing of herbicides in the field. The search for native plants as sources of supply for medicinal drugs and insecticides has continued, and a list of publications of the Division during the year is appended.

In the Division of Economic Entomology, the most important development during the year has been the change in the cattle-tick situation as a result of the thorough establishment during the year of the practicability and efficacy of using a water-miscible preparation of D.D.T. in dipping-vats. This preparation was developed in June 1946 by a team of the Division's workers in Queensland.

Much of the work of the Division on the chemical control of insect pests has been concerned with the use of D.D.T. and 'Gammexane', very promising results being obtained in Western Australia with these dusts against the red-legged earth mite. Biological-control investigations form a major part of the Division's activities and have progressed very satisfactorily. The introduced insect enemies of St. John's wort continue to clear land of the weed at an undiminished rate, and new projects which have been initiated include: the introduction and breeding of parasites of the cabbage moth; a biological study of the Dawson River sandfly; laboratory studies of factors controlling the levels of insect populations; and ecological studies of cockchafer beetles. A meeting of the Codling Moth Committee, at which all the State Departments of Agriculture were represented, as well as the Waite Agricultural Research Institute and the Division itself, was convened at Canberra in May 1947. The Division of Animal Health and Production continued its work on the usual lines, but difficulties arose in all branches of the work, mainly through the shortage of accommodation, supplies and staff. Plans for the development of the work on animal breeding, genetics and animal production, however, were advanced during the year, and in the Department of Biochemistry and General Nutrition increased attention has been given to research on more fundamental spheres of the nutritional physiology of sheep.

Soils investigations have again largely been concerned with areas intended for land-settlement schemes for returned servicemen and especially those areas in which a major change in the use of the land is contemplated, such as from dry farming to irrigation or from native vegetation to seeded pastures. Studies on soils associated with toxæmic jaundice of sheep have continued, while, besides the investigation of methods of determining phosphates in soil, a new method has been developed for the determination of molybdenum in plant materials. The principles underlying retention of water in soils have been further studied, and investigations, which were commenced for the Building Materials Section, on soil as a foundation material for houses, have continued.

Considerable progress is reported in forest products investigations, and fundamental studies on wood chemistry and pulp and paper problems have been continued in co-operation with the pulp and paper industry. With the object of accumulating the requisite background and information for an examination of saw-mill design, saw-mill studies have been carried out in Queensland in co-operation with the Queensland Sub-Department of Forestry and the Queensland Timber Stabilization Board, and in Victoria with the Victorian Saw-millers' Association. Work on the thermal conductivity of wood and on creep in initially green beams has continued, and an attempt was made to standardize the methods of electrical strain-gauge manufacture and to improve the technique of the manufacturing process. Other work, on the seasoning and the preservation of timber, particularly the preservative treatment of the tree-wood of eucalypts of lower durability for railway sleepers, has yielded important results; and work on the latter problem has indicated that a study of the diffusion of electrolytes into timber offers a possible approach to fundamental aspects of the physical chemistry of wood.

Besides the changes in food-preservation investigations recorded in last year's report, the Physics and Transport Section has commenced a major investigation of the transport of frozen produce in insulated railway vans, and more attention has been given to several long-term chemical and biological studies. Investigations of the volatile organic substances from Granny Smith apples, the mechanism of catalytic oxidation of ascorbic acid by metals, and the stability of dehydroascorbic acid were carried out; the anti-bacterial properties of cationic detergents, the maturation or tenderizing of beef, the damage to beef casings by *Dermestes vulpinus*, and skin coatings for apples also received attention; and the programmes of work on fruit canning and the dehydration of fruit and vegetables have been carried out. Further progress is reported in the development of the schedule of fisheries research, but, although all sections of the freshwater, estuaries and inshore programme were extended, deep-sea investigations on pelagic fish occurrences with the motor vessel *Warren* could not be resumed until January 1947. During 1947–48 it was hoped to extend the exploratory and survey work to tropical waters. An exceptionally interesting report records progress in survey work or investigations on pilchards, sprats, anchovies, whitebait, trawl fish, Australian salmon, mullet, shellfish, marine crayfish, etc., as well as in hydrological and seaweed investigations.

The Division of Metrology reports increased attention to the maintenance of standards and associated research, including the measurement both of mass and length and associated quantities. The Division of Electrotechnology has likewise been able to give more attention to fundamental research and is developing its research activities mainly on the electrical and magnetic properties of materials and mathematical instruments; work in the former direction has been so far confined to dielectrics, including the treatment of glass, steatite and other siliceous compounds to improve their electrical insulation resistance to moist atmospheric conditions, and the relation between molecular structure and dielectric properties of insulating materials. A more balanced programme of work has been possible in the Division of Physics, where about half the time of the scientific staff is now available for research. Three new major projects have been commenced: the setting up of equipment for research at very low temperatures; laboratory investigations on the artificial production of rain; and the absolute measurement of ultra-violet spectral energy distributions with the view of determining solar energy distributions. Advice has been given on special devices for temperature measurement and control, and work is also reported on the physical phenomena involved in the formation of ice crystals, on the physics of solids, photometric standards and evaporation plant.

In the Division of Aeronautics greater concentration on the fundamental and long-term projects was also possible, and, while the Australian Council for Aeronautics was disbanded during the year and will be replaced by a research committee, the relations of the Division with the Universities of Sydney and of Melbourne have already been strengthened. Reference is made in the report to work on such varying topics as the stability of plates and shells, the life of aircraft and effect of temperature on their strength, fatigue of metals, properties of alloys, powder metallurgy, high-speed subsonic and transsonic flow, the use of suction to increase efficiency at moderate speeds, piston-ring lubrication and the elimination of wear due to dust. In the Division of Industrial Chemistry progress is reported in the inauguration of ceramic research, but the work of the Biochemistry and Organic Sections has been handicapped by absence of proper accommodation. Construction of a new building was expected, and in the meantime the work of the Division has continued much on the lines described in the last report. Collaboration with the Division of Physics in studies of the structure of the wool fibre continued, and theoretical and experimental investigations have been conducted on luminescent materials used in the lamp and radio-valve industries.

Work in the Division of Radiophysics has led to fuller knowledge of the radiations emitted at radio frequencies from the sun and in the universe. This Division has opened up a promising new avenue of research which should provide basic information on the physics of cloud formation and may lead to the practical possibility of stimulating rainfall by artificial means and to the completion and successful demonstration of new radar aids to civil aviation. The Section of Tribophysics has confined its work on lubrication mainly to a study of the frictional properties of molecular layers of lubricating substances. Wear is being studied by mechanical and metallurgical methods as well as with a radioactive tracer technique. The group dealing with the mechanical properties of metals is endeavouring to obtain a better knowledge of the properties of metallic crystals and the way the mechanical properties in particular are changed by heat. The work on explosives has already made substantial contributions to knowledge of the mechanism of explosion in liquids.

The work of both the Building Materials Research Laboratory and of the Flax Research Laboratory has been seriously handicapped by limited accommodation and, for the former, by the further difficulty in recruiting staff. Nevertheless, weathering studies have proceeded, as well as investigations on concrete, masonry, surfacing materials, building boards and insulating materials, adhesives, etc. The Dairy Research Section, which has now incorporated the Dairy Section of the Division of Industrial Chemistry, has studied the advantage of eliminating the washing of buttermilk from the butter granules, weed taint in butter and the utilization of the solids of skim milk. Among miscellaneous investigations is included an account of the study of the growth and rubber content of the guayule plant under Australian conditions at the Waite Institute, Adelaide, which was commenced five years ago and which is now approaching a stage when interesting and important comparisons will be possible.

DESIGN OF RADIO AERIALS

THE number and diversity of the radio communication services now in operation in an overcrowded spectrum demands that the utmost efficiency must be obtained in the design and operation of both sending and receiving stations. At the transmitting end it is necessary that the minimum power be used and the radiation be concentrated in the desired direction; while at the receiving end aerials of high directivity are also required in order to ensure that the incoming field produces a satisfactory signal, to the exclusion of any unwanted noise or radiation coming from some other direction.

Thus, in point-to-point communication it is desirable to make the two aerial systems as directional as possible. At fixed frequencies high directivity can be obtained by using aerial-array, long-wire, or rhombic aerial systems, but if several frequencies are to be used with the same system, aerial arrays are unsuitable.

A report which will help the engineer in designing a radio communication service for maximum efficiency has recently been published*. It presents in a convenient form a generalized analytical method of calculating the polar diagram of any long-wire aerial system over a wide band of frequencies. The analysis is also applied to the determination of the polar diagrams of horizontal rhombic aerials.

The object of the paper is to describe the simple theory of long-wire aerials in such a manner that the physical principles involved may be readily understood and the results applied to special or new systems. Methods are developed whereby the probable polar diagrams of long-wire systems may be rapidly estimated for a wide range of operating frequencies or for changes in other parameters. These may be used to reduce the work involved in calculating an accurate polar diagram in which allowance is made for second-order effects; the technique is to sketch the approximate polar diagram given by the simplest theory applicable to the problem, and then to calculate the exact values for the important maxima and minima. The results of the analysis are presented in the form of design charts with such information as: families of contour curves of constant directivity against angle of azimuth and elevation for a constant frequency; or as curves giving the position and relative amplitude of the main lobes in the vertical plane through the aerial against angle of elevation and frequency. A similar treatment is

* Department of Scientific and Industrial Research. Radio Research Special Report No. 16. A Method of Determining the Polar Diagrams of Long-Wire and Horizontal Rhombic Aerials. By W. R. Piggott. Pp. iv+39. (London: H.M. Stationery Office, 1948.) 9*d*. net.

followed for the case of the horizontal rhombic aerial. The methods described may easily be applied to other types of long-wire aerial, or to linear arrays of aerials having constant input amplitude in each aerial, and constant relative phase shift between aerials.

The approximate methods described are particularly useful when calculating coverage areas obtained by reflexion from the E- or F-regions in the ionosphere. It is unnecessary to know the polar diagram shapes exactly as the movements of the reflecting layers from day to day cause appreciable changes in the exact zone covered, and the approximate results are therefore of great practical value.

MIDDLE DEVONIAN OSTEOLEPID FISHES OF SCOTLAND

FOR more than a century, since the days of the pioneer workers on the Old Red Sandstone, the osteolepid fishes have proved a source of difficulty to vertebrate palæontologists, and even more so to stratigraphers. One has only to glance at the restorations of the whole fishes on p. 103 of Dr. E. Jarvik's recent monograph* and of the heads of the various forms dealt with to understand why. For so uniform in general are their characters that unless the bodies are well enough preserved to show the details and the disposition of the fins it is almost impossible to be certain even of the genus, and if the skull-roof is not clearly shown then the species is more often than not in doubt; and finely preserved bodies and clearly detailed heads are not so very common in these ancient strata, laid down 300 million years ago. The long historical accounts of each of the three genera and seven species described clearly indicate the confusion that has arisen in the past, and even Dr. Jarvik's exhaustive investigations leave some loose ends for future workers to tie up.

The group is a most important one, anatomically by reason of its close relationship to the fishes from which the land vertebrates sprang, and geologically as one of the dominant types present in these complicated stratal series. This fine volume is a worthy addition to the classical series of exhaustive and luxuriant memoirs on the early fossil Vertebrata that have issued in an endless stream from the Stockholm school under the guiding genius of Prof. Stensiö, and in it Dr. Jarvik gives a full account of the external anatomy of this difficult group and of its systematics, which will long remain a standard on the subject, even if one cannot accept all his conclusions. The long-fought controversy regarding the identity of the external bones of the skull, upon which their nomenclature, of course, depends, is again gone over, and Dr. Jarvik has decided definitely in favour of the 'Fusionist' or Swedish school of thought as against the 'Replacement' or Anglo-American school. Yet Dr. Jarvik himself makes some admissions and expresses some doubts, though of a minor nature, as to the completely universal application of his conclusions—much depends on analogies with similar structures in modern fishes; and the evidence of analogies is not always conclusive, especially as no living fishes are closely related to the archaic osteolepids. We may perhaps be pardoned, therefore, for hesitating to believe that the final word on the subject has been written.

The stratigraphical results are important, but before full advantage can be taken much new collecting would be necessary—and that, unfortunately will not be possible in all cases. The early collectors of fossils, and not only of Old Red fishes, either did not appreciate the need for exact localization, or deliberately omitted details from labels in order to keep to themselves the whereabouts of 'rich strikes', and so the source of many of the specimens is uncertain.

Finally, Dr. Jarvik is not quite clear on the rules of systematic nomenclature. In naming a group of the genus *Osteolepis* which Pander had apparently wrongly referred to Agassiz's uncertain species *O. microlepidotus*, he calls it *O. panderi* (Pander). Pander may have properly defined this group for the first time, but a name cannot be attributed to a man who died decades before it was invented (and anyway, why in brackets? Pander at least put it in the right genus); and the species, if valid, must be known as *Osteolepis panderi* Jarvik. This is a minor point, and it is, perhaps, ungrateful to mention it in reviewing a work of this importance; but whatever one may think about the subject of systematic nomenclature, it has a proper function and should be used correctly, especially when the author makes some show of taking the matter seriously by quoting rules and opinions, and particularly in a volume that is likely to remain the standard work of reference on the subject for some time to come. Errol White

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* On the Morphology and Taxonomy of the Middle Devonian Osteolepid Fishes of Scotland. By E. Jarvik. Kungl. Svenska Vetenskapsakademiens Handlingar, Serien 3, Band 25, No. 1. Pp. 301 + 37 plates (Stockholm: Almquist und Wiksells Boktryckeri A.-B., 1948.)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 14

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. O. G. S. Crawford: "Some Mediaeval Theories about the Nile Basin".

University of London (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. T. G. Ridling: "The Translation of Technical Education".*

Chemical Society, Eire Section (joint meeting with the University College of Dublin Chemical Society and the Werner Society, in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Prof. T. S. Wheeler: "The Development of the Periodic Table".

Tuesday, March 15

Chemical Society, Leeds Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Leeds), at 5 p.m.—Display of Scientific Films; at 6.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Structural Relationships amongst the Polysaccharides".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. J. Emeléus, F.R.S.: "Some Recent Advances in Radiochemistry". (Further Lectures on March 22 and March 29.)

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. G. P. Tyrer: "Outline of the History and Development of the Beet Sugar Industry in Great Britain".

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. K. de B. Codrington: "Cultivated Cereals and Early Civilizations".* (Further Lecture on March 22.)

Society of Chemical Industry, Plastics Group (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. D. L. Clarkson and Mr. N. D. MacLeod: "Polyvinyl Chloride Pastes".

Institution of the Rubber Industry, London and District Section (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Mr. W. H. Reece: "Continuous Vulcanisation Processes".

Institution of the Rubber Industry, Scottish Section (at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow), at 7.30 p.m.—Annual General Meeting; Dr. W. J. S. Naunton and Mr. J. M. Buist: "Rubber to Metal Bonding".

Wednesday, March 16

Association of Applied Biologists (in the large Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road (morning session), and the Metallurgy Lecture Theatre, Prince Consort Road (afternoon session), London, S.W.7), at 11.45 a.m. and 2.15 p.m.—Papers on "Growth-promoting Substances in Agriculture and Horticulture".

Royal Institute of Chemistry, London and S.E. Counties Section (joint meeting with the London Branch of the Institute of Physics, at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. F. J. M. Stratton, F.R.S., and Mr. F. Hoyle: "The Chemistry and Physics of Hot Stars".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Charles Reid and Dr. William Reid: "The Reconstruction of the British Mining Industry" (Cadman Memorial Lecture).

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Meteorology in Agriculture" (to be opened by Dr. H. L. Penman and Mr. R. W. Gloyne).*

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. Gerhard Tintner: "Foundations of Probability and Statistical Inference".

Manchester Literary and Philosophical Society, Social Philosophy Section (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Mr. Michael Oakeshott: "What is Political Philosophy ?"*

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. I. M. Dawson: "The Electron Microscopy of Animal Viruses".

Royal Statistical Society, North-Eastern Group of the Industrial Applications Section (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. W. J. Jennett: "The Integration of Elementary and More Advanced Statistical Methods in the Control of Processes".

Thursday, March 17

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. M. Bruckshaw: "Geophysics and Economic Geology".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. Zassenhaus: "The Theory of Space Groups".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "The Physics of the Solid State". (Further Lectures on March 24, March 31 and April 7.)

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. Mullin and Mr. C. G. I. Gardiner: "The Design of Propellers".

Society of Chemical Industry, Road and Building Materials Group (joint meeting with the London Group of the Industrial Applications Section of the Royal Statistical Society, at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Mr. F. Garwood: "The Use of Statistical Methods in Road Research Problems".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Discussion on "Aspects of Heterogeneous Catalysis" (arranged by Dr. R. Holroyd).

Chemical Society, Edinburgh Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. F. N. Woodward: "Recent Trends in the Industrial Utilization of Agricultural Products in North America".

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8 p.m.—Mackenzie Davidson Memorial Lecture.

Friday, March 18

Physical Society, Acoustics Group (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Ir. E. W. van Heuven: "The Acoustics of Bells".

Chemical Society, Birmingham Section (joint meeting with the University Chemical Society, in the Main Chemistry Lecture Theatre, The University, Birmingham), at 4.30 p.m.—Dr. F. G. Mann, F.R.S.: "Some Aspects of Stereochemistry".

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Mr. K. A. B. Gilfillan: "The Use of Radar Beacons".

Imperial College of Science and Technology (at the City and Guilds College, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. Jean Laurent: "Reduced Scale Models in Hydraulics and in the Construction of Sea Ports—some Novel Observations".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 6.30 p.m.—Annual General Meeting; at 7 p.m.—Dr. W. F. Berg: "Recent Views on the Theory of the Photographic Latent Image".

Society of Instrument Technology, Midland Section (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. W. Wilson: "The Microscope in Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "Neutron Diffraction by Crystals".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Analyst, Mineral Nutrition of Plants and Soils—The Secretary, Long Ashton Research Station, Long Ashton, Bristol (March 19).

Lecturer in Rayon Technology, and a Senior Assistant with suitable qualifications in economics, industrial administration and management, in the Bradford Technical College—The Director of Education, Town Hall, Bradford (March 19).

Principal of the Municipal Technical College—The Chief Education Officer, West House, Halifax (March 19).

Research Assistant in the Department of Anæsthetics in the Medical School—The Registrar, King's College, Newcastle-upon-Tyne (March 19).

Senior Fellowships (2) and Junior Fellowships (3) in the Research Laboratory for Nuclear Physics, Lahore, Pakistan—The Educational Attaché, High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1 (March 21).

Lecturer in Bacteriology and Research Assistant—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (March 21).

Warden (who will be the Chief Administrative Officer) of the Liverpool Institute of Education—Dr. J. F. Mountford, The University, Liverpool (March 21).

Chair of Engineering—The Registrar, The University, Nottingham (March 22).

Assistant Keeper in the Department of Natural History, and a Keeper of the proposed Technical and Science Museum—The Director, City Museum and Art Gallery, Birmingham 3 (March 23).

Laboratory Workshop Officer in Electrical Engineering, a Laboratory Workshop Officer in Radar and Telecommunications, and an Officer-in-Charge of Mechanical Engineering Workshops, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2438 (March 24).

Deputy Director, an Engineering Geologist, and Field Geologists, in the Burma Geological Department—The Burmese Embassy, 19a Charles Street, London, W.1, quoting No. 3AP49 (March 25).

Principal Scientific Officer (microbiologist, pathologist or physiologist with research experience), a Senior Scientific Officer (physicist with a special knowledge of electronics and research experience), and a Senior Scientific Officer (chemist with research or works experience), in the War Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2454 (March 26).

Scientific Officers (with a good honours degree in a biological science or in chemistry), and Experimental Officers (with a minimum of 3 years' laboratory experience in pathology, bacteriology, biochemistry or physiology), at Ministry of Supply Research and Development Establishment in Wilts and Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.550/48 (March 26).

University Lecturers in Agricultural Botany, Farm Machinery, and the History and Economics of Agriculture, and a University Demonstrator in Agriculture—The Secretary, School of Agriculture, Cambridge (March 31).

Physicist in the Magnetic Survey, Christchurch—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 1).

Beit Fellowships for Scientific Research—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (April 2).

Senior Technician and a Technician—The Dean, Postgraduate Medical School of London, Ducane Road, London, W.12 (April 12).

Senior Lecturer (Grade I) in the Department of Physics—The Registrar, The University, Liverpool (May 1).

Lecturer in Mathematical Statistics, and an Assistant Lecturer in Applied Mathematics—The Registrar, The University, Liverpool (May 1).

Beit Memorial Fellowships for Medical Research—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (May 14).

Assistant Water Engineer in the Colonial Geological Survey Service, Cyprus—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27079/35.

Plant Geneticist in the Agricultural Department, Government of Tanganyika—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Economic Botanist in the Department of Agriculture, British Guiana—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Lecturer in the Department of Aircraft Propulsion—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

Lecturer in Mathematics—The Principal, Guildford Technical College, Stoke Park, Guildford.

Senior Assistant in the Department of Civil and Mechanical Engineering—The Principal, Technical College, Queen Street South, Huddersfield.

Technical Assistant in the Research Physics Department—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

Lecturer in Biology—The Principal, Medway Technical College, Gillingham, Kent.

Physicist in the Biochemical and Endocrinological Research Department, and a Senior Biochemist—The Medical Superintendent, Bristol Mental Hospitals, Barrow Hospital, Barrow Gurney, near Bristol.

Senior Scientific Officers and Scientific Officers in Government Departments throughout Great Britain—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2351.

Mathematician (with interest both in mathematical solution of engineering and physical problems and in statistical treatment of research data) in the Scientific Research Department, Derby—The Scientific Research Manager, Railway Executive, London Midland Region, Euston Station, London, N.W.1.

Research Physicist—The Director of Research, British Scientific Instrument Research Association, Sira, Southill, Chislehurst, Kent.

Senior Laboratory Technician for Department of Neuropathology—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5.

Lecturer in Anatomy—The Secretary, The University, Aberdeen.

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SCIENTIFIC AND CULTURAL CO-OPERATION

ONE factor which has hindered constructive discussion in Great Britain of the United Nations Educational, Scientific and Cultural Organisation is the comparative inaccessibility of many of the official documents. Although reports of the Beirut Conference last year do not yet appear to be available, the publication of Dr. Julian Huxley's second report as director-general (see p. 457), covering the activities of the Organisation during 1948, has made possible a fresh appreciation of the value and prospects of the Organisation. Together with a debate in the House of Lords on January 26, it serves to correct some ill-informed criticisms, and indicates both some of the achievements to the credit of Unesco and some weaknesses that require attention.

Reference was made to this report in the House of Lords debate, notably by the Bishop of Chichester; but this reference gave no idea of the value and scope of Dr. Huxley's valedictory message. Even more valuable than his detailed account of activities, which on some points of presentation is open to criticism, is the general survey which precedes the detailed report. In this survey Dr. Huxley picks out for emphasis special features of the work of the Organisation which he regards as specially important or noteworthy. He then indicates certain difficulties inherent in the early years of a young organisation and some achievements which warrant confidence in its future. Next he deals with some current criticism of its activities, and, suggesting that the unifying idea behind all the activities of Unesco is the advance of world civilization, he records finally some of the conclusions which he has reached as a result of the three years he has spent with the Organisation.

Before examining Dr. Huxley's conclusions, it is as well to note that both the report and speakers in the House of Lords debate clearly distinguished between the administrative weaknesses and the character as well as the execution of the programme of the United Nations Educational, Cultural and Scientific Organisation. These two aspects have been much confused in current criticism, and it should be noted that, as Lord Addison pointed out, in replying to the debate on behalf of the Government, great improvements have already been made on the administrative side in the financial control. The statement on this point made by the auditors, which Lord Addison quoted, is explicit and re-assuring. While the laxity in the expenditure of public money in 1946 cannot be condoned, there can be little room for doubt that the Organisation is outgrowing some of those administrative difficulties inherent in any body which is staffed by several nationalities.

Policy, however, or the general programme of the Organisation, is another matter from accounts or day-to-day administration, and it is here that much criticism appears to be unsound and sometimes badly misplaced. Dr. Huxley's report should help to put matters into a true perspective and to stimulate constructive criticism at the points where it is most needed and where it can be most effective. The general approval of the central idea of promoting a better understanding between the peoples of the whole world which lies behind all the activities of Unesco has not prevented a considerable amount of criticism of the general policy and tendencies of the Organisation; and the one main criticism which Dr. Huxley is disposed to admit is that greater attention should be given to the formulation of a central idea or aim which the ordinary citizen can understand and appreciate. It is for this reason that, as already indicated, he suggests that the underlying idea is the advance of world civilization. The advance of civilization on a world basis is regarded by him as both practical and concrete, the summation of a series of definite and limited tasks, without introducing a note of ideological theory. It commends itself immediately to the educated portion of the world's population and can be readily made intelligible and desirable to the rest. It can readily be fitted into the broader concept of evolutionary progress but is quite independent of it.

Dr. Huxley does not attempt to formulate a detailed definition, but directs attention to the large area of common agreement as to the meaning of his terms. The advancement of civilization clearly implies the better cultivation of the arts of peace; the advance of knowledge and the exploration of new outlets for creative activity and expression; the emergence of new enjoyments and new possibilities of individual and social development; and, in terms of Unesco's competence, although it demands an increasingly complex material basis and social organisation as its foundation, it is primarily concerned with science and culture and with education as the method of transmitting them. In arguing thus, Dr. Huxley does not over-stress the place of science and scientific technique, the dominance of which was deplored in the House of Lords debate by the Bishop of Chichester, who stoutly challenged the view that science by itself could do much to improve the world, and pleaded eloquently that in the future development of the Organisation special attention should be paid to culture in all the richness of the meaning of that word. This speech, although a protest against excessive preoccupation with the material aspects of civilization, clearly recognized that science itself is one of the cultural elements in human life. Dr. Huxley similarly suggests that the advance of civilization consists essentially in the development of the higher activities of the human mind and spirit which can be shared without being destroyed or divided quantitatively. The idea of world civilization, moreover, transcends both nationalism and the collaboration of separate sovereign nations, and one suggestion put forward by Dr. Huxley for consideration is that Unesco should delegate an important part of its work to private individuals chosen, not as official delegates of Governments, but as leaders of civilization—outstanding thinkers, artists, writers and men of science, owning their allegiance not to nations but to humanity—representatives of departments of the human mind. Such private individuals would be in a position, Dr. Huxley believes, to give a lead to a unitary world civilization on many subjects where official delegates would be restrained; and in particular that only to such individuals could be entrusted the task of defining the phrase 'world civilization' and of describing what Unesco should do for its advancement. He visualizes the growth in this way of another international non-governmental organisation which would possibly act as a general spearhead for the Organisation.

This outlook is probably too optimistic, as is also the theme that the advance of world civilization necessarily excludes ideological differences. It is the totalitarian systems that represent the greatest obstacle, far greater than ascetic philosophy; for they deny the human freedoms on which creative activity depends, and they would render sterile and ineffective the participation of individuals, however eminent, in such an organisation as is suggested. They deny the loyalty to a world civilization which is presupposed, and require subscription to new dogmas which may not be scrutinized by the free spirit of scientific inquiry.

That obstacle has to be recognized; but nevertheless it is right to advocate increasing delegation of discussion in particular fields to the unofficial and individual level. Much of Unesco's most valuable work has, in fact, been done in this way. Already, the International Scientific Unions are functioning more effectively because of the help given to them by the Organisation, which has contributed during 1947 and 1948 about half a million dollars in grants-in-aid to the Unions, and has been instrumental in the formation of a new International Union for the Protection of Nature.

The wisdom of using existing organisations in this way cannot be challenged, and with its fellowship programme, facilitating the interchange of men of science and other scholars and its work in the reconstruction and rehabilitation of learned institutions, the Organisation has solid achievements to its credit.

Two of these spheres of work should find a permanent place in the programme of the Organisation, even when the reconstruction and rehabilitation work is completed and the "Book of Needs" no longer issued. Moreover, it will be noted that totalitarian regimes such as Soviet Russia have taken no more part in such activities than they have in Unesco itself, a fact that in itself demonstrates how far we have yet to go before we can speak with any sense of universality of a 'world civilization'. That, however, constitutes the real challenge to the creative and constructive thinking that should precede both criticism of Unesco's present programme and the formulation of alternative plans for achieving human understanding.

The very existence of the United Nations Educational, Scientific and Cultural Organisation is a challenge to men of science, philosophers, artists, writers, teachers and thinkers everywhere. To achieve a deeper sense of intellectual and moral solidarity between the nations of the world is an exacting task, but may be a condition of the survival of mankind. The methods by which it is to be achieved may still require discovery, and the task is far too large and important to be left to the permanent officials and delegations of the Organisation alone. It is already clear that American men of science are making a real attempt at such constructive thinking, as are shown by Dr. Bok's article "Unesco and the Physical Sciences" in a recent issue of the *Bulletin of the Atomic Scientists* and the replies received to the inquiry on "Science and the Maintenance of Peace" initiated last June by the Committee on Science and its Social Relations of the International Council of Scientific Unions. British scientific workers and other men of learning will have to co-operate more fully with their American and other colleagues to enable the purposes of Unesco to be achieved and its projects stripped of the vagueness of which Lord Simon in particular commented in the House of Lords.

Certain other points in Dr. Huxley's report should help in such thinking. He stresses, for example, the need for giving closer attention to the raising of education, science and culture to the international plane ; and, indeed, beyond that to a plane where they can be treated as aspects of the welfare of humanity as a whole. For support he looks to a *rapprochement* between scientific method and empirical practice in the higher reaches of human psychology. The social sciences have also important contributions to make to the solution of such problems as the mobilization of leaders of thought and creative expression throughout the world to carry forward the idea of a world civilization ; they assist both governments and peoples to comprehend the importance of the arts and of the æsthetic and emotional, as well as the scientific and intellectual, foundations of a world civilization.

The comparative neglect of art by Unesco is recognized by Dr. Huxley ; but here, as in the field of culture generally, great care and constant scrutiny by creative, practical minds will be needed to see that projects do not become vaguely idealistic. Last but not least, what he has to say about Unesco's contribution to world peace deserves attention. The programme of the Organisation is, it is true, in large part designed to lay the foundations for a more united and peaceful world ; but this should not be taken to mean that all its activities must be directly and immediately relevant to the preservation of peace. Some of its effort must be directed towards setting up the mechanism required for the existence of a truly peaceful world ; but that mechanism in itself is no guarantee of peace and could even in certain circumstances be turned against peace.

To provide a clearing house of information, a common pool of information on which all nations can draw in solving their own immediate educational, scientific and cultural problems, to assist the more efficient organisation of research in the natural and the human and social sciences so as to facilitate the solution of the problems of humans as a whole—these are recognized as essential elements in the function of adapting knowledge for the common good. No less important is that of distributing grants in aid of approved projects, whether their execution is entrusted to Unesco itself or to other bodies, and the need for careful scrutiny and constructive criticism of such projects ; nevertheless, Dr. Huxley is right in pointing out that concentration on three or four projects would not suffice to achieve the real purpose of Unesco, and to secure that men in all nations recognized and accepted a new and compelling loyalty.

We can, in fact, only be content that Unesco should concentrate for the present on a short-term programme provided that the creative thinking that must form the basis for long-term schemes is proceeding. We are only on the threshold of learning how to treat tensions affecting international understanding, and there is little to guide us along sound lines of approach. Professional associations, not only of scientific workers but also of teachers, writers, artists and many others, can make a vital contribution to the work of the Organisation in such matters. Dr. Huxley's report contains much material to stimulate the thought which will be required. British men of learning will surely not fail to follow the outstanding lead already given in the United States, and take a worthy part in the elaboration of an adequate programme and also in ascertaining the philosophical foundations for it.

MODERN RESEARCH IN RETINAL PHYSIOLOGY

Sensory Mechanisms of the Retina

With an Appendix on Electroretinography. By Dr. Ragnar Granit. Pp. xxiii+412. (London, New York and Toronto : Oxford University Press, 1947.) 35*s*. net.

THIS book is not a general treatise on vision, but deals in detail with some additions to visual physiology in the last fifteen years that have been derived from the study of action potentials of the retina and the optic nerve, and particularly with work in this field with which the author has been closely associated and in which his laboratory has been notably active. It has been possible in many types of visual sense organ to record nerve impulse discharges set up by the stimulus of light ; in work on a simple eye (*Limulus*), Hartline showed that visual sense cells, like other sensory nerve endings that have been investigated, set up impulses of frequency related to the strength of the stimulus, and Hartline later confirmed this for single optic-nerve fibres from the frog's retina. But here the response was complicated by fibres responding when the light was extinguished—the well-known off-discharge found by Adrian and R. Matthews in the eel's optic nerve. Granit's work has extended this investigation to mammalian eyes ; and the response in single optic-nerve fibres in many eyes has been studied and related to the wave-length of the light evoking it.

The author's dominator-modulator theory of colour vision is considered in detail, though the elaborate transformations to which the experimental results are subjected in order to yield the modulator curves are scarcely sufficiently stressed, nor are the many assumptions implicit in these transformations considered. Hartline has given clear evidence in the frog's retina of the large number of retinal elements converging on to a single optic-nerve ganglion cell. Granit's work has shown that both rods and cones converge on a common final path. It seems to the reviewer that Granit's observations have not demonstrated the presence of distinct pathways for the clearly distinguished modalities required to fit any of the existing colour-vision theories. As the existence for specific colour pathways has not been clearly demonstrated, if animals possess wave-length discrimination, it must be considered whether it is possible that the modalities can be transmitted by a single fibre by the pattern of impulses occurring in the final common path. There is some evidence in Granit's work, briefly mentioned, that the relative proportions of the on- and off-discharge of a single fibre are greatly influenced by the wave-length of incident light; this observation would appear to merit much more consideration than it has yet been given, and more detailed experimental exploration. It certainly suggests an escape from the present impasse produced by many observations that all the receptors present appear to converge on similar final common paths in the optic nerve; and it is difficult, therefore, to see how the higher centres can be informed of the particular receptors stimulated except by the patterns of nerve impulses occurring.

The book contains a wealth of interesting matter from the author's own experimental work taken from his many recent papers; but as a review of recent advances in retinal physiology it is a pity that more rigid selection was not used to reduce the excess of detail so that general principles would be more clearly defined. This makes the book more valuable to the specialist than to the student; unfortunately, much of the detail given is in deduction from experiment without the experimental observations from which alternative treatments of the data might be tested.

The wealth of detail in the present volume shows clearly that visual physiology is in a state of rapid advance and almost embarrassed by the wealth of observation that has yet to be fitted into the theory; for the theory has not yet advanced sufficiently to accommodate all the newer observations, which sometimes, therefore, appear to be conflicting.

The volume is well produced with nearly two hundred illustrations and a large bibliography.

B. H. C. MATTHEWS

PHYSICAL CHEMISTRY OF HIGH-POLYMERIC SYSTEMS

The Chemistry of High-Polymers

By Prof. C. E. H. Bawn. Pp. x+249. (London: Butterworth's Scientific Publications, Ltd., 1948.) 17*s.* 6*d.* net.

NOTABLE advances in our knowledge of the physical chemistry of high-polymeric systems have been made by British chemists. This is particularly true of those parts of this subject concerned with the mechanism and kinetics of addition polymerization of vinyl compounds, the thermodynamics of solutions of rubber, the application of physical methods to the elucidation of structure, and the behaviour of high polymers under applied stresses. It is therefore the more surprising that the book under review is the first on this subject to be published in Great Britain. If such a volume has been long overdue, Prof. C. E. H. Bawn's book has been well worth waiting for and, in the reviewer's opinion, deserves, and will probably secure, a much wider range of readers than that for which it was written.

The complete study of a single high-polymeric system is especially instructive because it illustrates such a variety of chemical principles and problems. First comes the preparation, in the desired degree of purity, of the basic material to be polymerized. This, largely organic, aspect is omitted by Prof. Bawn, and it might therefore be argued that his title should read "The *Physical* Chemistry of High-Polymers". Next, the chemical route must be discovered by which the monomer is transformed to the polymer. Accordingly, the early chapters are accounts of the kinetics of the rate of formation, and the molecular size distributions, of the product. Two major routes are distinguished: polycondensation and addition polymerization. The former is much the simpler kinetically and involves the consideration of only one velocity constant. Addition polymerization processes have all the complexity of chain reactions and involve the following: initiation processes, which may be stimulated by catalysts or radiation or both, and suppressed by inhibitors; propagation reactions and their reverse; chain transfer; and termination by a variety of methods. Such complexity makes clarity of presentation at once essential and difficult to attain without loss of continuity, and the author is to be congratulated on the large measure in which he has succeeded. Minor corrections and omissions are bound to arise. For example, on p. 55 a mechanism for destruction of diradicals by *p*-benzoquinone is presented which is contrary to Melville's findings, and the expression at the bottom of p. 15 for photochemical initiation must surely be f(IM).

Polymer molecules are the very antithesis of the idealized collision-theory concept of an incompressible sphere. Their size and shape can be determined by very varied observations on solutions of polymers. These methods are critically discussed, and the author is careful to emphasize that owing to the flexibility of the chains the results obtained only refer to the condition of the polymer in the particular solvent concerned. The gross disparity between the size of an extended polymer-chain and a solvent molecule implies that the entropy of dilution is far from ideal. If the interactions between polymer pairs, solvent pairs and polymer-solvent pairs are also widely different, appreciable heats of solution may be expected. Both these factors must be disentangled and their origins understood if the colligative and other properties of polymer solutions are to be significant. Chapters 4–5 are models of clear elementary expositions of these topics.

The author next considers what can be discovered concerning the finer structure, that is to say, the molecular architecture, of polymers. The mechanism of formation is often suggestive, and chemical analysis may provide an answer of partial validity; but the least ambiguous methods are the analyses of the absorption spectra and X-ray diffraction patterns. The latter tool is particularly valuable also for the clues which it can provide as to the degree of crystallinity of a solid polymer.

Many lecture audiences will have seen 'bouncing putty', which typifies the unusual physical properties that a polymer may display. Appreciable progress towards the understanding of the causes of the various types of response to applied mechanical and electrical constraints has been made in the last ten years, and the author has given a lucid account of these researches.

In such a vast field, any author of an elementary text must be selective, and any reviewer must resist the temptation to complain if his hobby-horses are not ridden, provided the book fulfils the purpose for which it was written. Prof. Bawn has achieved his object brilliantly, and there can be little doubt that his book will rapidly and deservedly become a standard university text.

The publishers of the book have departed from the usual English scientific book practice in certain respects. *Times* New Roman type has been employed, and this contributes greatly to the ease of reading. The same cannot be said of the other features. There is no author index, and the subject index is both incomplete and badly cross-referenced. Where subdivisions of sentences or paragraphs occur, brackets are rarely placed round the number or letter. This makes for difficult reading even when the letters are italicized. On p. 46, brackets are employed, and the pleasing contrast with the earlier part of the same paragraph where they are omitted is most noticeable.

F. S. DAINTON

MOHENJO-DARO AND HARAPPA

Early Indus Civilizations

By Dr. Ernest Mackay. Second edition, revised and enlarged by Dorothy Mackay. Pp. xiv + 169 + 30 plates. (London: Luzac and Co., Ltd., 1948.) Stiff paper, 15*s.*; cloth, 17*s.* 6*d.*

STUDENTS of Indian archæology will welcome this second edition of Dr. E. Mackay's useful text-book on the Indus civilizations. The magnificent volume of Sir John Marshall on "Mohenjo-daro and the Indus Civilization" is far too expensive for the average archæologist, and the other publications of the Archæological Survey of India are also expensive and not easily accessible. In this new edition the illustrations have been enlarged and increased in number; but it is a pity that the amulets referred to on pages 59–60 are not included in the additional illustrations

Interpolations have also been made in the text to bring it up to date in accordance with the results of field-work carried out since the first edition was published, and an addendum at the end gives a general view of the conclusions to be drawn from this later work. Thus the linking up of Harappa material with Sumerian and Babylonian chronology involves a consequential change in Harappa dating which would nearly, if not quite, bridge the gap between the Indus civilization and the invasion of the Aryan-speakers. This implies a very long period at Harappa with a remarkably slow rate of change. There is nothing inherently improbable in this, and a parallel can be found in the continuing culture of Atchama-Alalakh which was reported by Sir Leonard Woolley in 1947. Other examples can be provided from Arabia, and such a slow rate of change is probably typical of India. It is not impossible that the cities and wealth of the Dasyus, Nagas, etc., mentioned in the Rigveda and the early epics, have reference to the Indus civilization, and that the tradition which describes the Dasyus as black and noseless may have been taken over from a race of previous invaders and interpreted in the course of time as referring to the immediate precursors of the Aryan-speakers.

The graphs on the seals are also discussed, but it is unlikely that these inscriptions will be deciphered until some bilingual record with a second character has been discovered.

The index has been extended, and there have been added an air photograph of the Mohenjo-daro site and plans of the city. The number of plates has been doubled, but the absence of scale is a serious drawback; for example, there is nothing on the plate to tell the student that the steatite bust depicted on Plate 16 is not life-size, instead of being, as it is, on a miniature scale; one may be permitted to hope that the next edition will give not only scales to the illustrations, but also some reference to the relative pages of the text.

J. H. HUTTON

BEQUEST TO BIRD-LOVERS

Birds in Britain

By Frances Pitt. Pp. viii+576+17 plates. (London: Macmillan and Co., Ltd., 1948.) 25*s.* net.

DURING the Second World War the amount of bird-watching and the number of bird-lovers in Britain increased considerably. This has led to a steady stream of books on birds and their behaviour, to cater both for the experienced bird-watcher and for the enthusiastic beginner. But no apologia need be made for the appearance of yet another book on birds, since "Birds in Britain" is the fourth of the now well-established "in Britain" series which have been enthusiastically received by many readers. Previous issues in the series have dealt with flowers, trees and dogs, and now comes Miss Frances Pitt with her long experience and discerning eye. In her book are found not only scientific accounts of wild and domestic birds in Britain but also personal anecdotes which enliven the text and captivate the reader. Her experiences have been gathered in many parts of the British Isles and have given her an 'understanding' of birds which, by description, she successfully transmits to her readers. These descriptions are supplemented in many instances by well-chosen and apt literary references both from the classics and lesser-known works.

Nor is the text the only delightful feature of this book. The frontispiece consists of a painting by Winifred Austen on which it would be hard to improve either in the original or as a reproduction. Roland Green has painted a series of sixteen plates which, because of their natural effects, are a joint tribute to artist and publishers. Miss Pitt herself has contributed a number of clear, explanatory line drawings, and the book is also provided with a large number of black-and-white photographs drawn from the rich store of our leading bird photographers. The reproduction of some of these is probably the only blemish in a book which will be of value to the specialist, and generate enthusiasm with the not so learned. For the specialist better accounts of certain topics like "Birdsong", "Migration" and "Territorial Behaviour" may be found elsewhere; but it is probable that of all works on birds this book comes nearest to providing something of interest both for the specialist and the novitiate. There is evidence that its predecessors have helped to kindle the enthusiasm of many beginners in the study of trees and flowers, and it will not be surprising to learn later that "Birds in Britain" has increased the number and knowledge of bird-lovers in Britain.

T. H. HAWKINS

Symposium on Methods of Penicillin Assay

Their Purpose, Scope and Validity. (The Society of Public Analysts and Other Analytical Chemists: Physical Methods Group and Biological Methods Group.) Pp. iv + 34. (Cambridge: W. Heffer and Sons, Ltd., 1948.) 3*s.* 6*d.* net.

MUCH of the value of scientific symposia and conferences is apt to be lost in these days of publication difficulties. For example, the papers read at the International Congress of Pure and Applied Chemistry some eighteen months ago remain unpublished, except as abstracts on bits of common paper. It is therefore especially commendable that the Society of Public Analysts and Other Analytical Chemists (like the Biochemical Society also) has achieved relatively prompt publication of symposium papers. The symposium on "Methods of Penicillin Assay" was held on January 29, 1948, and was reported in *Nature* of February 21, p. 285. The papers and discussion were published in the April and May issues of *The Analyst*, and have since been reprinted as a handy stiff-covered booklet, uniform with reports of previous symposia on polarography, chromatography and spectroscopic analysis. The report can probably claim to cover every known method (about forty in all) for assaying total penicillin or individual penicillins, by chemical, physical or biological means. Its importance lies not only in this completeness, but also in the fact that some of these methods have not been published previously, except in war-time reports of limited availability. It is unfortunate that some important methods are mentioned only in the introductory surveys, and therefore briefly, while there are full papers on others of less importance. However, this kind of uneven weighting is inevitable at any symposium.

Working Plans for Estate Woodlands

By N. D. G. James. Pp. ix+93. (Oxford: Basil Blackwell, 1948.) 6*s.* 6*d.* net.

IN the past it was not so much the owners of estates as their factors and agents who were against the 'working plans' for woodlands. It is all to the good that Mr. N. D. G. James emphasizes in a book of considerable merit the importance of the necessity for making plans for small woodlands. He explains clearly enough the form the plan should take, and how information and statistics should be collected. This is all good, concise and clear. He correctly insists on the formation of compartments and other allotments or divisions of the areas, but a serious omission is that nothing is said about yield calculation; this title is even omitted from the headings given of the plan. The intention is expressed of not wishing to frighten owners with complexities and unnecessary technicalities, but one cannot call the calculation of the yield either the one or the other, for the necessity is obvious.

I am unable to follow the author in his divisions of the 'working plan' into three under the titles of a "Full Plan", an "Intermediate Plan" and a "Short Plan". The 'working plan' remains as such whether made for (1) a large area of forest with at present only a small demand for its produce and thus requiring only a simple plan; (2) a large area of forest under intensive management requiring detailed plans; or (3) an area of simple coppice requiring only a simple prescription. The main headings of the 'working plan' are the same for all, and any modifications required can be made in the prescriptions, such as planting, natural regeneration, felling proposals and so forth. It is suggested that pages 6–15 dealing with the headings of the three types of plan are likely to prove intimidating to the owner. Altogether this book is quite a good piece of work in many of its parts; the omission of any methods of calculating the yield is a pity. In his fear of becoming complicated and complex in items of management, the author seems to have unnecessarily complicated simplicity.

E. P. STEBBING

Poudres et explosifs

Par Henri Muraour. (Que sais-je ?, les points des connaissances actuelles, No. 259.) Pp. 136. (Paris: Presses universitaires de France, 1947.) n.p.

THE author of this volume has had unusual experience in writing about his subject; the present work is mainly addressed to those with some scientific background who wish to have a brief but broad account of the nature, classification and testing of organic explosives, and of their future military uses as propellants, in minefields, and for demolition purposes. The format somewhat resembles that of the 'Penguin' series.

For those with some acquaintance with the subject, interest will centre on the chapter on the decomposition process, which includes records of work by the author and his colleagues. The detonation of initiators *in vacuo* is explained by a chain mechanism in which activated decomposition-products bring about further reaction by 'resonance' with unchanged molecules. The *brisant* nature of initiators may be annulled if they are ignited in a high-pressure gas; this phenomenon is left unexplained, pending further investigation.

For high-explosives, the hydrodynamic theory, as elaborated by Schmidt, Jouguet and others, is adopted. Here the experiments of Muraour have included studies of the luminosities of shock waves in monatomic gases; the higher figures found in argon as compared with helium are explained as being due to the higher atomic weight. Vassy found that four millilitres of a mixture of tetranitromethane and toluene, when detonated in argon, gave an intensity of four hundred million candle-power in a flash, lasting four millionths of a second. Comparison of these shock-wave intensities with those produced by meteors promises to give interesting results.

W. E. BATTY

Directory of Museums and Art Galleries in the British Isles

Compiled by Major S. F. Markham. Pp. viii+392. (London: Museums Association, 1948.) n.p.

ALTHOUGH much of the information contained in this directory is also available in the Libraries, Museums and Art Galleries Yearbook, 1948, those who are not chiefly requiring information about libraries or about overseas institutions will probably find the directory the more convenient to use. The information given is slightly fuller, and some details are supplied of museums closed through lack of local interest or of financial support, those destroyed or damaged by enemy action and those occupied by Government departments. Museums closed at December 1947 are listed in an appendix, with remarks on the situation and prospects of re-opening. Although the volume includes no index, the alphabetical arrangement by towns and villages is adequate for most purposes, and the book is well printed and produced.

R. B.

NINTH INTERNATIONAL CONFERENCE OF WEIGHTS AND MEASURES

THE ninth International Conference of Weights and Measures was held in Paris in October last. Under the terms of the international treaty known as the Convention du Mètre, these Conferences should be held every six years. But on this occasion the Conference which should have taken place in the autumn of 1939 had had to be deferred, owing to the Second World War, until 1948, with the result that the normal interval was increased to fifteen years.

In the meantime the International Bureau of Weights and Measures at Sèvres had pursued its activities, though not without difficulties both financial and technical, due to the abnormal conditions of the times. In particular, the International Committee which governs the Bureau under the general authority of the Conference was also unable to meet between 1937 and 1945. It will be appreciated that, in these circumstances, many changes had occurred in the interval, and the 1948 Conference had before it an unusually heavy agenda.

The opening session took place in the Salon d'Horloge at the Ministry of Foreign Affairs in Paris, under the presidency of the French Foreign Minister, M. Robert Schuman. Subsequent meetings were held at the International Bureau under the presidency of M. Henri Villat, the president, or his deputy, M. Louis de Broglie, the permanent secretary of the Paris Academy of Sciences. The members were also entertained by M. Vincent Auriol, the French President, at an informal reception at the Elysée.

The Conference was attended by fifty-five representatives of twenty-eight States adhering to the Convention. Only five States were unable to send delegates: two of them, Germany and Japan, because, at the time, they were without autonomous Governments. Great Britain was represented by Sir Charles Darwin, director of the National Physical Laboratory, Mr. H. Barrell, the official delegate, and Mr. J. E. Sears, president of the International Committee, which was in session concurrently with the Conference and functioned in an advisory capacity. It will doubtless be remembered that the International Committee itself enjoys the assistance of three technical consultative committees, for electricity, for photometry and for thermometry and calorimetry.

The first session was purely formal, being confined to a speech of welcome by M. Schuman, and replies by Mr. Sears and M. Villat. The first business at the second session was the establishment of the credentials of the official Government delegates who held the right of vote for their respective States. At this stage there was an intervention by the Russian delegation, who objected to the presence of Spanish representatives at the Conference; they directed attention to the refusal of the United Nations to admit Spain to membership. It was pointed out that the Convention du Mètre had no connexion with U.N.O., that its functions were entirely non-political, and that each contracting State, having paid its subscription, was equally entitled to participate in the proceedings of the Conference. Although the Russian delegation formally reserved the right to revert to this question, it was not, in fact, raised again.

The Conference then proceeded to the consideration of the various items on its agenda. Mr. Sears reported on the activities of the Bureau since the previous Conference, in 1933, and asked for formal sanction to the results of comparisons made, during the past fifteen years, of various national copies of the metre and kilogram. These results were highly satisfactory. With the exception of two kilograms, the masses of which were known to have diminished owing to wear, the new values, both for the metres and the kilograms, agreed, within quantities small enough to be accounted for by the combined errors of the two determinations, with those obtained when the standards were first authorized in 1889. Incidentally, it was reported that the historical Kilogramme des Archives, also included as a matter of interest in the recent re-comparisons, showed a diminution of mass of 0·4 mgm. This caused no surprise, as the material of construction of this old weight is known to be inferior to that of the international standards. It may be remarked that the British Standard Pound, the material of which may be supposed to be similar to that of the Kilogramme des Archives, has exhibited a similar loss relative to the current metric standards.

Consideration was next given to the possibility of the eventual replacement of the material prototype standard of the metre, in platinum-iridium, by a definition of the unit of length based on the wave-length of light. This is an old proposal which has received a considerable impetus in recent years as a result of the separation of sensible quantities of isotopic materials—in particular of krypton-84 in Germany and of mercury-198 in the United States. These isotopic elements provide sources of even more homogeneous radiations than the red line of cadmium which has hitherto been accepted as the standard of reference for spectroscopic measurements, and open up the possibility of a new definition of the unit of length, free from the objections hitherto urged against the use of a wave-length of light for this purpose, which would afford the prospect of a clear advance in precision. The Conference voted a resolution recognizing these facts and inviting the principal national laboratories and the Bureau International to pursue the study of these new sources with the eventual object of establishing such a definition.

The next subject to be considered was the value of the acceleration due to gravity. Determinations at the National Physical Laboratory, Teddington, and at the National Bureau of Standards, Washington, have indicated that the accepted reference value for standard gravity, derived from the earlier Potsdam determinations, is appreciably in error. All these values result from pendulum observations. Experiments have already been initiated with the approval of the Committee at the Bureau International with a view to a new determination by direct observation of the movement of a body (a graduated line standard) falling *in vacuo*, using modern techniques for the precise measurement of times and displacements. Recommendations in nearly similar terms were submitted to the Conference by the Russian and Spanish delegations urging the desirability of further gravity determinations. After discussion, the Conference voted a resolution recognizing the interest of the work already in hand at the Bureau, and inviting other laboratories which may be in a position to do so to undertake comparable measurements.

On the subjects of electric and photometric units, the Conference had little to do except to take note of, and confirm, the decision already taken by the International Committee, in pursuance of the instructions of the previous Conference, that the new units should come into force as from January 1, 1948. It may be worth while to recall that the relationship of the old to the new (absolute) electric units is 1 mean international ohm, $\Omega_M = 1{\cdot}00049$ absolute ohm; 1 mean international volt $V_M = 1{\cdot}00034$ absolute volt; and that the new unit of candle-power, which in future is to be designated 'candela', is defined as "such that the brightness of an integral (black body) radiator, at the temperature of solidification of platinum, equals 60 candela per square centimetre".

With regard to thermometry, the Conference accepted a revised text of the International Temperature Scale, recommended by the International Committee on the advice of its consultative committee. This is a very detailed statement. It may be useful to record that the primary fixed points of the scale are:

	Temperature 0° C.
Boiling point of oxygen	−182·970
Melting point of ice (fundamental point)	0
Boiling point of water (fundamental point)	100
Boiling point of sulphur	444·600
Solidification point of silver	960·8
Solidification point of gold	1063·0

Temperatures in the revised scale are to be quoted as °C. (Int. 1948). It should also be mentioned that, after discussion, it was unanimously agreed to describe temperatures in this scale as degrees "Celsius" instead of Centigrade or Centesimal. Objections were raised to both the latter on different grounds.

Turning to a more fundamental question, it was agreed that the thermodynamic scale should, in principle, be based on a single fixed point, namely, the triple point of pure water, which should have the value + 0·0100 degree, together with the absolute zero, the value of which should be fixed at a later date, when more precise measurements are available.

It was also agreed that the unit of heat should be the 'Joule', and it was remitted to the International Committee to establish a table relating the value of various 'calories' to the Joule, in accordance with the best available experimental data.

The Conference also referred to the Committee the task of instituting an inquiry among all the contracting States as to the opinions held with regard to the possible formulation of a common practical system of units of measurement suitable for adoption by all countries using the metric system, and of making recommendations.

Following an initiative of the International Union of Physics, the Conference adopted a table of nomenclature and symbols relating to a selected group of quantities which were held to come within its domain. It also approved a proposed recommendation that, so far as Europe is concerned, words ending in ". . . illion" should be accepted as referring to successive powers of 10^6.

Approval was given to a proposed agreement for mutual co-operation between the International Committee and the United Nations Educational, Scientific and Cultural Organisation on questions of common interest.

The Conference next addressed itself to the regulation of the scale of subscriptions for the various countries adhering to the Convention. Proposals for further extensions of the activities of the Bureau were put forward by the Russian delegation and referred to the Committee for study. A suggestion was made by the Swiss delegate that the Governments of the contracting States might be invited to supplement their statutory contributions by voluntary donations to facilitate such additional undertakings.

Finally, the Conference proceeded to the re-election of the International Committee. Many members of the Committee elected in 1933 have since died. In addition to seven former members who retain their seats, the following were elected, or re-elected after retirement by rule: L. de Broglie (French), G. Cassinis (Italian), E. C. Crittenden (American), M. Dehalu (Belgian), W. J. de Haas (Dutch), T. Isnardi (Argentine), H. Nagaoka (Japanese), Z. Rauszer (Polish), M. Siegbahn (Swedish).

The Conference passed in an atmosphere of friendly co-operation, and it will be seen that it accomplished successfully a large programme of work covering a very wide field.

EVOLUTION OF COLOUR VISION

A DISCUSSION of the evolution of colour vision took place at the general meeting of the Linnæan Society on February 24. Dr. R. J. Pumphrey, while disclaiming expert knowledge, said that it seemed fitting that a zoologist should have been invited to open the discussion rather than a specialist in human colour vision, however knowledgeable, since a zoological training enforces a historical outlook, which is essential for the ultimate understanding of the evolution of function. The evidence available from animals other than mammals, though extremely relevant, is still scanty; inferences from structure and physiology cannot be relied on. Colour vision can only be ascribed to an animal when the intact animal, either in the field or in a controlled experimental situation, has been shown to exercise a choice depending on colour discrimination. Such a test is always a matter of extreme technical difficulty, and is not applicable to any animal without restriction but only to those whose habits and motivation make them suitable subjects. In spite of these limitations, colour vision has been demonstrated beyond reasonable doubt in a number of insects, notably aculeate Hymenoptera, Diptera and Lepidoptera, and a number of vertebrates, notably teleost fish, reptiles, birds and primates.

This demonstration leads immediately to two obvious questions. To what extent is the fundamental mechanism of colour vision similar in these animals? And to what extent is it utilized in a similar way? To the first question, the best available answer comes from measurements of the least perceptible difference in wave-length ($\Delta\lambda$) of pure spectral colours as a function of wave-length. This function is of identical form for man (Wright), pigeon (Hamilton and Coleman) and minnow (Wolff). The maximum and minimum values of $\Delta\lambda$ occur at the same values of wave-length λ. For the bee the curve has the same general character but is displaced, one minimum value of $\Delta\lambda$ being in the ultra-violet near 3800 A. (Kühn). It is reasonable to conclude that in all these cases colour vision depends on the existence of three or more types of photoreceptor with different absorption spectra. None of these curves has the least resemblance to the discrimination curve of a human dichromat, although it has been suggested that dichromatism is an essential stage in the evolution of full colour vision.

It does not follow, however, that colour vision has the same character in all these animals. Kühn's work appears to show that the effect known as simultaneous colour contrast, which is of trivial importance in human vision, is dominant for the bee. If this be the case, no object of small angular subtense in the bee's visual field will be intrinsically coloured; its apparent hue will depend primarily on the background against which it is seen.

The human eye unaided cannot distinguish spectral green from a suitable mixture of spectral blue and yellow, but a match so made will no longer be a match when seen through a coloured filter. A proportion of the cones of a bird's retina contains red and yellow oil droplets each of which is a colour filter for its own cone. Hence it is obviously physically possible for a bird to distinguish impure colours which are indistinguishable to man without extraneous aids. These examples indicate that in spite of a fundamentally similar mechanism of colour vision in different animals, the quality and extent of the information about the environment which their eyes collect need not be the same or even similar.

The fact that colour vision appears to be demonstrable in just those animals whose habits lend it a particular importance suggests that the fundamental mechanism is an essential attribute of any highly organised eye, and one which may or may not be exercised in the direction of colour vision according to need. Hartline's and Granit's demonstration of receptors of different spectral sensitivities in the retinæ of a number of animals which are certainly colour-blind supports this conclusion.

Dr. E. N. Willmer said that, in spite of many attempts, colour vision had not been demonstrated in any mammal outside the primates. The primate stock was in all probability nocturnal in habits, with a retina dominated by rods, a rod being defined as a visual receptor cell containing rhodopsin and being maximally sensitive at 500 $\mu\mu$. A cone contains a pigment other than rhodopsin and is maximally sensitive at 570 $\mu\mu$. Histologically, although they are typically very different, they may in certain species and situations be difficult to distinguish. Moreover, rods themselves may differ widely in their power to accumulate rhodopsin, and Granit has demonstrated the existence of distinguishable groups of high- and low-threshold rods in cats and guinea pigs. It is probable that, in view of their evolutionary history, the mechanism of colour vision in mammals may be quite different from that of birds, which is probably wholly dependent on cones. Dr. Willmer said he would submit evidence that in primates colour vision depends on rods and cones; neither alone can produce the sensation of colour.

In the colour vision of primates, the most important part of the retina is the central part of the *macula lutea*, which is called the *fovea*, and subtends an angle of about 2°. Within the fovea is the central 'rod-free' area subtending less than 1°, with greatly diminished power of dark-adaptation and containing no low-threshold rods. The normal fovea in man is trichromatic and must contain at least three types of receptor elements with separate pathways to the colour-analysing centre of the brain. The rod-free area, however, behaves as a dichromatic system. Within it all spectral colours can be matched by mixtures of red and violet.

Subjects who confuse red and green (both protanopes and deuteranopes) are completely colour-blind in the rod-free area. Any spectral hue can here be matched to any other by altering its intensity only. They differ, however, in the spectral sensitivity of this area, protanopes being relatively insensitive to red and deuteranopes falling into two classes, normal (type I) and relatively insensitive to blue (type II), respectively. It is inferred that the sensitivity curves of the protanope and the deuteranope (type II) represent respectively the spectral sensitivity of the two elements normally present in the rod-free area. For the deuteranope (type II) the inference is strongly supported by the way in which the thresholds for red and violet light respectively are modified by previous exposure to high intensities of red or violet. The deuteranope of type I has normal sensitivity and adaptation, indicating that both 'red' and 'green' receptors are present in the central rod-free area; but he is colour-blind because their output is not recognized as distinct by the central analyser. The deuteranope (type II) is colour-blind in the central fovea because only the 'red' receptors are present. Further, the sensitivity curve of the 'red' receptors is not so unlike the absorption spectrum of iodopsin as to exclude the idea that the 'red' receptors are, in fact, cones in which iodopsin is the sensitive pigment. In spite of certain complications in the adaptation results, it is probable that the protanope is colour-blind in the rod-free area because only 'green' receptors are present.

Histologically, two trends are distinguishable in the evolution of the primate retina: the specialization of the rod + mop-bipolar system for dim-light vision and of the cone + midget bipolar in the centre of the retina for good acuity at higher illumination. These lead ultimately to the existence of three pathways in the eye as a whole and two in the central fovea. The pathways are formed by the mop-bipolars relaying from low-threshold rods (the 'blue' pathway), the flat bipolars relaying from high-threshold rods and cones (the 'green' pathway), and the midget bipolars relaying from cones only (the 'red' pathway).

Both histological evidence of the evolution of the retina in primates and the evidence from the examination of colour-defect in man, Dr. Willmer said, are consistent with the existence of three types of receptor only, namely, cones, high-threshold rods and low-threshold rods, the two first only being present in the 'rod-free' area.

Admiral T. P. H. Beamish stressed the continuing importance for the Services of research on colour vision, relating that his own yeoman of signals had been found to be colour-blind after thirteen years of service. Dr. L. C. Thomson pointed out that Dr. Willmer was relying heavily on the fact that protanopes are totally colour-blind in the rod-free area. In Dr. Thomson's experience, this was not altogether true and a time factor was involved. The subject is conscious of a colour sensation initially, which changes or vanishes on continued fixation.

Dr. H. J. A. Dartnall raised the question whether the absorption spectrum of iodopsin is sufficiently close to the sensitivity curve of the deuteranope, type II, to justify the assumption that human cones depend on iodopsin.

Prof. H. Hartridge said that he could confirm the old observation of Holmgren that a bright yellow point centrally fixated could be seen as red, white, green or yellow and a blue point as green, white, blue or violet. How was it possible to reconcile this observation with the existence of only two receptor types in the central fovea ?

Dr. M. H. L. Pirenne suggested that more use might be made of the opto-motor reaction in investigating the colour-vision of animals by a method similar to that used by Hecht in determining acuity.

Dr. Willmer, in reply to Dr. Thomson and Prof. Hartridge, said that it was not really relevant to argue about whether or not a colour sensation was aroused in the subject. The crucial question was whether the sensation, whatever its subjective nature, could be matched tri-, di- or mono-chromatically.

Dr. Pumphrey, in reply to Dr. Pirenne, said that the difficulties of the technique suggested, if not insuperable, were so formidable that suspicion might attach to the results. The method had, in fact, been tried by Birukow on the frog with results in conflict with those of other workers. R. J. P.

PHYSICAL AND PSYCHO-PHYSIOLOGICAL ASPECTS OF COLOUR

THE British Psychological Society and the Colour Group of the Physical Society held a joint meeting, their first, in the Hastings Hall, Tavistock House, London, on February 12, when a number of problems about colour were discussed. Mr. J. G. Holmes, chairman of the Colour Group, was in the chair. Three main topics were introduced by members of a panel consisting of Dr. L. C. Thomson (Vision Research Unit, Medical Research Council), Mr. R. C. Oldfield (Institute of Experimental Psychology, Oxford), Dr. R. W. Pickford (Department of Psychology, Glasgow), Dr. W. D. Wright (Department of Optics, Imperial College of Science and Technology, London) and Mr. W. A. Allen (Building Research Station, Department of Scientific and Industrial Research). General discussion of each subject followed the contributions of the panel.

Dr. Thomson spoke first, on "The Measurement and Meaning of the Luminosity Curve". He emphasized the difficulties of determining accurately the forms of this curve, and outlined the two principal methods, namely, (*a*) obtaining brightness matches for a series of monochromatic stimuli against a standard monochromatic stimulus ; (*b*) determining the absolute intensity-threshold for a series of wavelengths. By these methods the photopic and scotopic curves are obtained, and their form and relative position in the spectrum suggest a number of problems, of which Dr. Thomson detailed two. The first of these is that of the shift in the position of the luminosity curve as conditions are changed from scotopic to photopic, and in this connexion he made reference to Dartnall's suggestion that such a shift might be produced by selective absorption by increasing concentrations of the breakdown product of rhodopsin—indicator yellow—under increasing light intensities. Such a hypothesis would, he remarked, predict a limited shift of about the correct amount. The second problem about the luminosity curves raised by Dr. Thomson was that of the secondary maxima, or 'humps' found on the photopic curve. He pointed out that if these are connected with independent colour mechanisms, doubts must arise regarding that part of the Young–Helmholtz trichromatic theory which postulates that a sensation of white is the product of the activity of the three colour receptors alone, and of no other mechanism.

Mr. Oldfield referred briefly to some of the problems, physical and psychological, which arise concerning the position of the luminosity curve in the electromagnetic spectrum, and the biological utility of colour vision. He cited Wall's view that, since the vertebrate eye evolved in an aqueous environment, the absorption spectrum of water must be one of the factors determining the position and extent of the sensitivity curve of the eye. He mentioned other physical factors which impose similar limitations. On the question of the biological utility of colour vision, he referred to the difficulties of determining accurately its incidence among animal species, and remarked upon its somewhat odd occurrence. He suggested that its chief utility lies in the enormous variety of discriminable patterns of visual stimulation that it affords, compared to the resources offered by mere intensity discrimination. He asked whether the actual incidence of colour mechanisms might not be bound up with the food habits of the species concerned.

Dr. Pickford spoke next on "The Inadequacy of Existing Tests of Colour Vision". He remarked first that most tests are vitiated by the fact that they were devised with a theory of colour defect in mind. Indeed, he said, most would be quite useless if the phenomena of colour-blindness did not show marked discontinuities. The tests are satisfactory only in so far as they are responsive to distinctions between the colour-blind and the normal. They have little capacity to separate out the anomalies. He then briefly criticized a number of tests in common use. Holmgren's wool-test had been effectively disposed of by Edridge-Green, who showed that it failed in many cases to detect defects of occupational significance. Tests of the Stilling and Ishi-Hara type serve to reveal the chief discontinuous classes of colour defect, but scarcely do much to distinguish the protanope from the deuteranope. Edridge-Green's bead test depends on naming, and no test should depend on this alone ; further, its yellow-blue section is ineffective, and the test generally is too easily passed by defectives. Lantern tests such as those of Edridge-Green and Martin depend on naming, itself a complex function. They also suffer from extreme intricacy of procedure, if the instructions are fully complied with. Spectrometer tests, again, rely on the expression of discrimination in terms of names, and suffer from the disadvantage that they require an experienced worker to administer them. They are also unable to deal with the red-green anomalies. The anomaloscope, finally, is excellent for the detection and measurement of red-green anomalies, but is unsuitable for use on other types of defect.

Dr. Wright maintained that the available tests are not entirely unsatisfactory, provided they are used for purposes to which they are suited. In occupational testing it is important in the first place to pick out the grosser defects, and to select those subjects who require further testing of a more special character. The Ishi-Hara test and the anomaloscope together will achieve this. The more special tests should be devised so as to provide as close an imitation of the occupational working conditions as possible. Dr. Wright emphasized that, as an occupational problem, colour-blindness cannot be treated in terms of discontinuities. The appropriate borderline must be fixed in the light of each type of occupational requirement and circumstance. For the scientific investigation of colour defect, all that is required of the tests is that they should be able to pick out with reasonable reliability those individuals requiring more intense study by specialized laboratory methods. Existing tests such as the Ishi-Hara satisfy this requirement.

The discussion was then thrown open to the meeting, and a number of members took part. Several commented on the usefulness of the Ishi-Hara test in examining school-children, and the view was expressed that, if used in suitably defined and standardized conditions, especially as regards illumination, the test is an effective one. Some discussion took place on the relationship of intelligence to colour-vision test performance ; and the implications of supernormal colour discrimination were briefly examined, together with the part played by training and practice. A number of remarks were also made concerning the conditions and significance of binocular chromatic fusion.

Mr. Allen then spoke on "The Effect of Colourful Decoration and Lighting". He explained that these problems, which are of great importance to the architect, builder, and industrial manager, fall into two types. In the first place, colour effects can be used in factories and other places of work to promote, through broadly æsthetic channels, cheerful and pleasant states of mind conducive to efficient work and the avoidance of fatigue. In the second, there are more specific problems of promoting physiological well-being by such factors as the avoidance of glare, the production of a feeling of warmth, and so forth. The first, more æsthetic, group of effects allows considerable latitude in the choice of suitable colour schemes. But in the case of the second, choice is dictated by the particular problems to be solved. Mr. Allen gave examples in which such choice had been successfully made. In one case lighting conditions, and particularly the absence of glare, in recently built schools caused the teachers to insist that they felt markedly less strain in their work, while the children showed a smaller tendency to somnolence in the afternoons. Mr. Allen concluded by remarking that what had hitherto been done towards a solution of these problems had been upon a somewhat intuitive and *ad hoc* basis, and he appealed for an attempt to be made towards a scientific formulation of the necessary principles.

In the course of the subsequent discussion, attention was directed to the difficulties of investigation in this field. Mr. Oldfield emphasized the danger of drawing conclusions from short-term experiments. At the same time, he said, there is a natural hesitancy in embarking on long-term investigations involving great expenditure of time and effort where so little is known of the individual factors that may play a part. Mr. H. D. Murray expressed himself as disappointed with what the psychologists had at present to offer. He had hoped that some relatively simple indicator of the effect of these factors might be devised, though he acknowledged that those commonly used, such as output, minor accident-rates, etc., in investigation of the effects of more specific environmental conditions were inappropriate in this field. He said that any good suggestions, even if they afforded only partial solutions, would be very welcome to people in industry.

The chairman, in both his opening and closing remarks, stressed the importance of bringing psychologists, physicists and physiologists together for the common discussion of the problems of colour. He was sure, he said, that such contacts would be very fruitful in suggesting valuable and novel experiments.

R. C. OLDFIELD

THE ROYAL INSTITUTION AND SCIENTIFIC RESEARCH*

By PROF. E. K. RIDEAL, O.B.E., F.R.S.

THE free and unfettered pursuit of knowledge which Rumford and Davy laid down as the object of the Royal Institution has had surprising results. This is not the place to catalogue the vast list of scientific discoveries which have emanated from the laboratories and desks in this building from the time of Rumford to the time of Dale. We usually associate the names of workers in science with some particular achievement, because that particular piece of work has had a great influence either on modern philosophical thought, or on some modern branch of experimental or theoretical science, or again, in some field of technological endeavour ; but their other and less-known achievements in different fields are not to be ignored.

The spirit of freedom and of inquiry is like the wind which bloweth whithersoever it listeth, and it may be of interest to examine the contributions which workers in the Royal Institution have made to the subject of the physics and chemistry of surfaces and colloids, a field in which the laboratory is especially interested at the present time, and to compare the methods of experimental approach adopted by them with those now current.

We usually associate the name of Count Rumford himself with the concept of the mechanical equivalent of heat ; but we find that he was interested in surface tension, and held several classes on the subject. In a similar manner, Davy, associated by us with the discovery of the alkali metals by electrolysis, the definition of acidity and the physiological effects of nitrous oxide, was interested in the movement of crystals of potassium acetate on the surface of water, and remarked that their lively motion was retarded by a layer of oil.

Observing that small solid objects could float on a water surface and that it was generally attributed to air adhering to the surface, Rumford devised experiments to prove this was not the case. One simple experiment consisted in allowing a needle to fall on a water surface under ether, when the needle remained suspended at the ether–oil interface. He concluded that the particles of water adhere strongly to each other, forming, in consequence, a kind of pellicle at the upper surface. With this concept he interpreted the concavity of a water surface confined in a small vessel, the suspension of water in a capillary tube and the like. He inquired as to the form of the sessile drop and noted that the resulting film at the surface must be extremely thin.

Rumford observed that Laplace's attractive forces in that writer's theory of surface tension are to be identified with his adhesional forces. He commented on the great author of "Mécanique Céleste" as follows : "I must confess that I am not sufficiently well versed in higher geometry to understand fully the calculations of M. Laplace on this subject, and I shall take good care not to pass judgment on them . . . but I have such a high opinion of the talents of this man, that I am always inclined to receive his opinion in matters of science, as well as on every other subject, with the greatest deference".

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* From a Friday Evening Discourse at the Royal Institution on March 4, in commemoration of its foundation on March 7, 1799.

It was doubtless Rumford's and Davy's work on surface tension that led Thomas Young to develop his well-known theory of cohesion and capillarity, which was singularly successful. Young was the first to deduce an estimate of molecular dimensions from data provided by that theory, to define exactly what is meant by the angle of contact, and interestingly enough, he examined the variation of that angle for metals amalgamated with mercury. He calculated the range of the cohesive forces to be 4×10^{-9} in., or one Angström. He developed the drop-weight method of measuring surface tension and took issue with Laplace on the origin of the surface forces, knowing, indeed, that repulsive, as well as attractive, forces were involved.

It is scarcely necessary to mention the contribution of Lord Rayleigh to the subject of surface tension—his method of measuring dynamic tension, which is now universal, and his estimation of the size of molecules by using Davy's experiment to determine the amount of oil required to stop the movements of camphor. He also investigated the theory of surface forces and showed how the theories of Laplace and of Young had to be supplemented by Gauss's hypothesis of surface potential-energy. Experimentally, he achieved a triumph in describing how he succeeded in spreading water on clean mercury.

Dewar examined the properties of soap films in detail, revealing their laminated structure and determining many properties such as their permeability to gases.

Another interesting phase of surface chemistry and physics is to be observed in the development of our ideas of heterogeneous catalytic action. Davy in his experiments on the miner's safety lamp showed that neither flame nor explosions would pass along narrow metallic tubes. In the case of explosions, we can understand the breaking of the wave front by the tube systems; but in the propagation of flame two factors have to be considered, namely, the loss of heat in the walls, and the catalytic activity of the walls. We now have evidence that in a number of cases in the propagation of flame there is an advancing front of free radicals and of hydrogen atoms. The power of metals to combine hydrogen atoms catalytically can be demonstrated in many ways. We may note that in Faraday's experiments on electrolysis the hydrogen atoms liberated at the electrode combine and come off as molecules, especially noticeable on platinum, where the over-potential is low. Later, the fact that the expected volumes of electrolytic gas were not always obtained led Faraday to his important investigation on the power of metals to induce the combination of gases. He propounded a theory of catalytic action which still has many protagonists. He regarded the gases as condensed on the surface by what we now call Van der Waals's or dispersive forces, a type of condensation used later by Sir James Dewar in utilizing cool charcoal for obtaining high vacua.

Faraday writes in his notebook, November 25, 1833, "Think this (surface adsorption) a subject of great consequence, for I am convinced that the superficial actions of matter and the actions of particles not directly or strongly in combination are becoming daily more and more important in chemical as well as in mechanical philosophy". Again, "Immerse the blade of a knife in water, on drawing it out it will not be equally wet, but the water will appear in particles or run into globules. But suppose you dip in the platina plate cleaned as directed, it comes out uniformly wet."

It is now possible to examine the primary products of catalytic actions by means of the mass spectrograph, one of which has been made in the Institution and is in use for this purpose. It was in the lecture theatre of the Institution that Sir J. J. Thomson gave the first account of his discoveries concerning the parabolas described by positive ions in a field, an effect from which Aston developed the mass spectrograph.

Surface chemical reaction was noted by Rumford, who showed that a pellicle of gold would develop at the interface between a gold chloride solution and ether, or on an impregnated carbon disk, on illumination; and Faraday carried out similar experiments.

We now have a more sensitive method of measuring these reactions at liquid surfaces by means of the phase boundary potential changes caused in chemical reaction.

In another field, I would like to refer to the light-scattering experiments of Tyndall, and the theoretical examinations by Lord Rayleigh which have led directly to the modern method of measuring the size of colloid particles, especially developed by Debye.

The work of Sir William Bragg on X-rays has led to the possibility of examining colloidal material by this method. It is possible from the X-ray spacings of solutions to obtain some of the dimensions of colloid particles such as the molecule of ovalbumin.

The subject of the physics and chemistry of surfaces, although only a small brick in the great edifice of science, yet contains within itself many interesting and wonderful things, and our present knowledge of what is sometimes regarded as a very recent development is, indeed, part of the heritage into which we enter when we work in the Royal Institution and in its Davy Faraday Laboratory.

It will not be denied that the Institution of Rumford and of Davy has not only pursued the objectives which the creators desired, but also has contributed continuously to the advancement of knowledge. We must now ask ourselves the question whether an institution founded one hundred and fifty years ago has a place or function in the Britain of to-day and to-morrow.

During the last decade, we have witnessed the gradual disappearance of an individualistic society. This change has been reflected in many aspects of science. We note the growth of the concept of the planned mass attack on specific problems by the co-ordinated efforts of teams of workers. One does not venture even to guess at the number of scientific workers engaged on the Manhattan project or on penicillin. There is much to be said for such developments in a technological sphere, especially as we are living in a world of fast dwindling assets:

> But where shall wisdom be found?
> And where is the place of understanding?
> It cannot be gotten for gold
> Neither shall silver be weighed for the price
>   thereof.
> Yea, the price of wisdom is above rubies.

In the exploration of uncharted seas which are lit by no beacon light, but illumined only by the inner light and imagination in the mind of the explorer, it is still, and must ever be, the individual. The characteristic, individualistic attitude of the workers in the Royal Institution can thus find a place in modern society. Indeed, if such places did not exist, we should have to create them in order not to lose our souls. How best to preserve its freedom of thought, and thus serve most effectively both science and the State, is an ever-recurring problem.

It is certain that Michael Faraday, whose name is most naturally associated with this Institution, would be the first to object to its conversion into a museum to perpetuate his memory. He would, we feel sure, prefer to see it as a live and active centre of research. Indeed, he could have no better memorial than a laboratory to which people interested in Nature and with inquiring minds could work. Some idea such as this must have entered the mind of Ludwig Mond, when he conveyed in 1896 the Davy Faraday Research Laboratory to the Royal Institution.

To solve this problem in all its functional and economic aspects, there is still much to do, and we of this generation must see to it that we do not, in spite of difficulties, fail to give an account of our service and stewardship.

I cannot do better than terminate with the words of Sir Humphry Davy:

"Let not the countrymen of Bacon, of Newton and of Boyle neglect those pure springs of knowledge from which these great men drew such copious supplies both for profit and for glory, and let it not be forgotten that science has its moral and intellectual, as well as its common aims, and its object is not only to apply the different substances in nature for the advantage, comfort and benefit of man, but likewise to set forth that wonderful and magnificent history of wisdom and intelligence which is written in legible characters both in the heavens and on earth."

OBITUARIES

Prof. T. S. Patterson

Thomas Stewart Patterson was born in Greenock in 1872. After his early education at Merchiston Castle School, of which in later years he became a governor, he studied chemistry at the Andersonian College, Glasgow, under Dittmar, and then proceeded to Heidelberg, where he graduated as Ph.D. in 1896 with a thesis on iodoso- and iodo-benzaldehyde. In this romantic city by the Neckar he fell under the spell of that man of genius, Victor Meyer, who was then at the height of his transcendent powers. After a year in Birmingham as the first Priestley scholar, he became a member of the staff of the Yorkshire College, Leeds, before he returned to Glasgow in 1904 as senior assistant to the professor of chemistry in the University, being afterwards promoted to Waltonian lecturer and lecturer in organic chemistry. He graduated as D.Sc. both in London and Glasgow, and in 1919 he became the first holder of the Gardiner chair of organic chemistry at Glasgow, which he occupied with distinction until his retirement in 1942. His services to the University were honoured by the conferment upon him of the degree of LL.D. in 1943. During his tenure of the chair he played his full share in administration, since he served for some years as dean of the Faculty of Science, and as a member of the University Court. The welfare of his students, with whom he was very popular, made at all times a great personal appeal to him, and he was one of the founders of the Alchemists' Club, which served so much to broaden their outlook.

It was one of the two pioneers of stereochemistry in Great Britain, namely, Prof. Percy Frankland, who attracted him to that particular branch which deals with the connexion between optical rotatory power and chemical constitution. His first paper on the effect of chloroacetyl groups on the rotation of methyl and ethyl glycerates and tartrates was published in 1898, and was followed by a long series of thirty-eight communications on the influence of solvents and other factors on the rotation of optically active compounds. Those researches, which were prosecuted in elaborate detail and with great regard for accuracy, displayed at once originality and experimental skill of a high order, and gained for him the reputation of being the leading authority on this fundamental theme. True it is that his early polarimetric measurements were confined to light of one wave-length only, and for that reason his deductions were occasionally somewhat lacking in conviction. But the valuable work of Pickard and Kenyon on optically active secondary alcohols attracted his attention to the necessity of extending his investigations to take account of results with lights of varying wave-lengths, while the usefulness of the characteristic diagram of Armstrong and Walker in correlating optical rotation data was also stressed. Even then, his results were occasionally difficult to interpret; the problem at issue was indeed a most evasive one. It was accordingly understandable that discussions with workers in the same field, such as Walden, Lowry and Pope, assumed at times a somewhat acrimonious trend. Well indeed might Patterson have exclaimed with Alan Breck, "And O, man, am I no a bonny fighter ?"

Other topics investigated dealt with optical superposition, and with the polarimetric study of intramolecular re-arrangement. The latter topic yielded some interesting results. Thus, the *syn-* form of benzaldoxime was shown to have a much more pronounced effect on the numerical value for the rotation of a solution in ethyl (+) tartrate than had the corresponding *anti*-oxime, so that the velocity of re-arrangement could be observed with ease. While other compounds were shown to display a similar transformation, it was noted that the purer the ethyl tartrate the more slowly did the interchange occur. Reference might also be made to his 'green' ethyl tartrate. 'Back to Pasteur' was the note struck in his final experimental contributions with Buchanan on the crystalline forms of various sodium and potassium tartrates. It always gave Patterson pleasure to show visitors to his laboratory those large crystals where the hemihedral facets stood out so beautifully.

No account of Patterson's work would be complete without reference to his scholarly writings on the history of chemistry. Those included aspects of Helmont, Beguin and Leblanc; most important was his elaborate critical survey of Mayow on respiration and combustion. In his later years he was more particularly interested in Paracelsus.

Patterson spent his vacations mainly on the Firth of Clyde, for he was an expert yachtsman, and a member of the Clyde Corinthian Club. His death on February 14 of this year will have recalled to his many friends the memory of a very upright and lovable man. Alex. McKenzie

Mr. Birrell Russell

On March 4, after making an adjustment at the top of the apparatus on which he was working, Birrell Russell slipped in some unexplained way and fell 33 ft. to the ground. He received very severe head injuries and died without regaining consciousness in the early morning of March 8.

Russell was a senior member of the staff of the Atomic Energy Research Establishment, Harwell, having been promoted to principal scientific officer in 1947. He graduated at Glasgow in 1933, taking first-class honours in mathematics and natural philosophy (second place for the year). He then did two years research work, as Houldsworth Research Scholar, on the diffraction of proton beams. From there, he went to the National Physical Laboratory, taking up radio research, and was transferred in 1937 to the Royal Aircraft Establishment, where he worked under Dr. A. C. Bartlett on very high frequency radio for aircraft. In 1940, he was moved to the Telecommunications Research Establishment, then at Worth Matravers, and remained with that Establishment throughout the War.

Russell's work at the Telecommunications Research Establishment was mainly on aerials for aircraft radar. He worked first on aerials for the early version of A.I., the radar device used by fighters to track down enemy aircraft in the dark. Later, he devised direction-finder aerials to enable our long-range fighters to home on to enemy fighters fitted with A.I. Thus he was able to develop a device which enabled our fighters to single out and destroy enemy night-fighters. This was put into operational use with excellent results in the British large-scale bombing offensive. At the end of the War, Russell worked on centimetre-wave aerials and was the author (or part author) of two papers on this subject in the *Journal of the Institution of Electrical Engineers.*

In the summer of 1946, Russell transferred to Harwell, where he was one of the first residents on the site. He was set the problem of isotope separation by the method of gaseous thermal diffusion. As a result of his work, he was able to set up a plant for the production of oxygen-18, enriched from its normal concentration in atmospheric oxygen up to about 20 per cent. This plant had been erected and tested, and was due to start production on March 7. The product was to be sent to the Medical Research Council for use as a non-radioactive tracer in important medical and biological work. It was after making a final adjustment to a water relay in preparation for the production run that the accident occurred.

Russell had considerable experience in the supervision of the work of junior staff and was in charge of a group working on various problems connected with isotope separation in the gas phase. He was a very energetic and capable experimentalist who had his heart in his work, and Harwell and the world of science generally have suffered a severe loss in his premature death. He leaves a widow and two small children.

H. W. B. Skinner

We regret to announce the following deaths:

Sir Thomas Hill Easterfield, K.B.E., during 1899–1919 professor of chemistry in the Victoria University College, Wellington, New Zealand, and director during 1919–33 of the Cawthron Institute, on March 1, aged eighty-two.

Sir William Hale-White, K.B.E., of Guy's Hospital, London, president in 1922–23 of the Royal Society of Medicine, on February 26, aged ninety-one.

Mr. James Hornell, known for his studies of primitive boats, on February 24, aged eighty-three.

Sir Archibald Page, formerly chairman of the Central Electricity Board, and president in 1927–28, and honorary member, of the Institution of Electrical Engineers, on March 7, aged seventy-three.

NEWS and VIEWS

Agricultural Research Council: Dr. W. K. Slater

With the approval of the Lord President of the Council and after consultation with the president of the Royal Society, the Agricultural Research Council has appointed Dr. W. K. Slater to be its secretary, in succession to the late Sir John Fryer, as from May 1. The Minister of Agriculture and Fisheries has agreed at the request of the Agricultural Research Council to release Dr. Slater from his present duties as a senior education and advisory officer in the National Agricultural Advisory Service. Dr. Slater was educated at the Oldham Hulme Grammar School and at the University of Manchester, where he graduated in 1914. In 1922 he joined the team working under Prof. A. V. Hill in the Department of Physiology, Manchester, and later followed Prof. Hill to University College, London. During the next six years, Dr. Slater held Junior and Senior Beit Memorial Medical Research Fellowships, and carried out a series of investigations on the anaerobic phase in muscular contraction and on the general phenomenon of anaerobiosis in animals. In 1928 Dr. Slater joined the staff of the Dartington Hall Trustees to set up a research laboratory and supervise the scientific aspects of their wide-scale experiments in rural economy, and later he was placed in charge of the administration of the agricultural departments of the Trust. Although personal research work was not possible, the laboratory at Dartington Hall under Dr. Slater's general supervision co-operated extensively with the research institutes on a wide range of problems, and did valuable work on the control of potato blight and on cobalt deficiency effects in sheep. In 1942 his services were loaned to the Ministry of Agriculture and Fisheries to assist the late Sir John Fryer in connexion with the Agricultural Improvement Council, and when Sir John became secretary of the Agricultural Research Council, Dr. Slater followed him as secretary of the Agricultural Improvement Council.

J. W. Döbereiner (1780–1849)

Born at Hof in Bavaria, Johann Wolfgang Döbereiner began as a pharmacist's apprentice in 1794, and later practised pharmacy at Dillingburg, Karlsruhe and Strasbourg, where he set up as a manufacturer of chemicals. For a time he conducted an institute for teaching practical chemistry; then he joined a textile company and set about improving dyeing processes. The Napoleonic wars ruined him; but he was fortunate to come to the notice of Goethe, who obtained for him a professorship at Jena, where he remained from 1810 until he died on March 24, 1849. Döbereiner is credited with improving (and giving a correct explanation of) the making of vinegar; but he is best known for directing attention, in 1817, to the fact that the atomic weight of strontium is the mean of those of calcium and barium. He also noticed the same relationship with other 'triads' (chlorine, bromine, iodine; sulphur, selenium, tellurium). Döbereiner's 'triads' passed unnoticed at the time, and only after Newlands' 'law of octaves' and Mendeléef's Periodic Law had been enunciated some fifty years later did Döbereiner's work attract attention. It is also not generally known that he introduced, in 1832, the method of preparing oxygen from potassium chlorate by heating in the presence of manganese dioxide.

Government Grants for Research and Development

In the Supplementary Civil Estimates for the year ending March 31, 1949, aggregating £221,471,574, there are various sums for scientific research and like purposes in Great Britain. The additional £1,950,000 for development and welfare (Colonies, etc.) includes a further £450,000 for research schemes, making a total for the year of £750,000. An additional Treasury grant-in-aid of £600,000 is required to meet liabilities maturing in respect of capital grants already approved to the Universities and Colleges of Great Britain. Of the additional £152,000 gross for the Department of Scientific and Industrial Research, £86,000 is required for grants to students and others engaged in scientific research, £5,000 for grants to research associations and other bodies engaged in industrial research to match increased industrial contributions, £34,000 for extra-departmental research work, £16,000 against salary revision and £11,000 for salary revision at the Geological Survey of Great Britain and the Museum of Practical Geology. Appropriations-in-aid and certain anticipated savings reduce the supplementary estimate to £81,000 net. The Ministry of Supply requires a further £1,760,000 net for research and development, of which £360,000 is for research and development work carried out by industry, and £2,150,000 gross for plant, equipment, stores and materials for Government establishments. Among miscellaneous items are grants-in-aid of £6,000 for the Institute of Public Administration, £12,000 for the Imperial Institute, £20,000 for the British Institute of Management and £25,000 to the Council of Industrial Design for preparatory work for the Festival of Britain, these last falling under the Board of Trade vote. The supplementary estimate for the Scottish Home Department includes a grant-in-aid of £20,000 for the National Trust for Scotland.

Human Skull from Fontéchevade, France

Two years ago it was reported that part of a human skull had been discovered at Fontéchevade in the Charente district of France. The importance of this discovery is related to its antiquity, for according to the preliminary account it was found in association with implements of Tayacian type and with remains of the 'warm' fauna which preceded the Würm glaciation. The skull, therefore, appears to antedate Neanderthal man and to represent the most ancient human remains (stratigraphically well documented) so far discovered in France. A note on the specimen by H. V. Vallois has recently appeared in *Comptes Rendus* of the Paris Academy of Sciences (February 14). Unfortunately this note is very brief, and is illustrated by only one outline drawing of the lateral view of the skull. The latter consists of the greater part of the parietal bones and approximately the upper two-thirds of the frontal. These bones are unusually thick, and in this feature are comparable to the Swanscombe skull (which dates from the middle Acheulean period). It appears also that, so far as some of their main characters are concerned, they show no evidence of Neanderthal affinities. The supra-orbital part of the frontal bone is unfortunately missing; but the position of the upper margin of the frontal air sinus is indicated, and from this it appears certain that the curvature of the forehead region of the skull must have conformed closely to that of *Homo sapiens*. In other words, there is no evidence of a heavy supra-orbital torus of Neanderthal type. So far as this rather meagre evidence goes, the Fontéchevade skull confirms the evidence of the Swanscombe skull from the Thames valley that Neanderthal man was antedated in Europe by a type of man which approximated in cranial characters more closely to *Homo sapiens*. It is to be hoped that a full and well-illustrated account of the Fontéchevade skull will not be long delayed.

Significance of Complementarity in Physics: *Dialectica*

The word 'complementarity' was originally introduced by Niels Bohr to express one of the most fundamental ideas in quantum theory, that we cannot simultaneously measure both the position and velocity of a particle—the more we know about one, the less we can know about the other. It is in this sense that we speak of our knowledge of the two quantities as complementary. But the idea is capable of wide generalization, since position and velocity (or momentum) are not the only pairs of 'conjugate observables'. Indeed, it is no exaggeration to say that a proper understanding of this principle is the greatest single contribution of modern physics to philosophy. The editorial board of *Dialectica*, a quarterly journal devoted to a review of the philosophy of knowledge, has done a public service by assigning the whole of the current issue (vol. 2, No. 3-4, published in Neuchâtel, priced 4.80 Swiss francs and obtainable from H. K. Lewis, 136 Gower Street, London, W.C.1) to a study of the single topic of complementarity.

The present issue is the more remarkable because no less than five Nobel prizewinners contribute to it. Pauli writes the editorial and briefly reviews the various subsequent contributions; Bohr describes the idea itself; de Broglie shows how it relates to the distinction between a complete unit (for example, a helium atom) and the individuality of its component parts (for example, electrons and nucleus); Heisenberg, to whom, of course, we owe the precise formulation of the uncertainty relations which lie at the heart of the idea, describes the progressive development of the concept; and Einstein restates one of his earlier arguments that present quantum theory is incomplete and requires to be supplemented, or replaced, by a new theory in which the state of any physical system is independent of any possible observations which might be made on it. Applications of the idea itself in the fields of biology and thought processes, and a possible way round some of the acknowledged difficulties in present-day quantum theory by the use of a non-Aristotelian three-valued logic in which statements may be either true, false or indeterminate, make up a most interesting volume.

Archiv für Meteorologie, Geophysik und Bioklimatologie

A NEW Austrian journal, *Archiv für Meteorologie, Geophysik und Bioklimatologie*, began publication last September under the editorship of Dr. W. Mörikofer (Davos) and Prof. F. Steinhauser (Vienna). It is divided into two series, (*A*) meteorology and geophysics, and (*B*) general and biological climatology (including their agricultural and micro aspects) and radiation phenomena. The issues will be of variable size, published (not at regular times) according to the material available; they will be combined into (probably annual) volumes each of about 400 pages. One part of each series appeared in September, (*A*) of 141 pages, price £1 5*s*. 6*d*., and (*B*) of 114 pages, price £1 3*s*. 0*d*. The first issue of series *A* contains seven articles and one note, all in German, but with abstracts in English (not always grammatical) and French. The authors are Courvoisier (barometric pressure variations), Defant (internal tidal waves), Reuter (heat balance of snow cover), Burkard (arctic ionosphere), Bouët (pluviology), Eckel (energetics of water-mixing), Toperczer (methodicity of land magnetic surveying), and Götz (note on auroral photography). The paper and printing are up to the known high standard of the publishing firm of Springer (now in Vienna), but an annoying and unnecessary inconvenience and waste of time are imposed on the reader by the fact that the pages are uncut; this practice has long been abandoned by many publishers, and it is difficult to see why any should continue it.

Journal of Geophysical Research

FROM March 1949 the journal *Terrestrial Magnetism and Atmospheric Electricity* will appear under the new title *Journal of Geophysical Research*. The change of name marks the transfer of editorship from Dr. J. A. Fleming to Dr. Merle A. Tuve, who is also a successor of Dr. Fleming in his other former capacity as director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Dr. Fleming, who has been associated with the journal almost since its inception by L. A. Bauer in 1896, becomes honorary editor; the journal, aided by a subsidy (which will be continued and somewhat increased) from the Carnegie Institution of Washington, was published on Dr. Fleming's own financial responsibility for more than twenty years, and he gave to it generously also of his time and effort. It is hoped that other organisations, both national and international, will assist the journal financially in future, and that, with the aid of a page charge in cases where contributors' papers are sponsored by institutions, it will be possible, despite the great increase in costs, to continue to publish the journal at the very moderate subscription-rate hitherto charged, namely, 3 dollars 50 cents for the four numbers per year. The change of title indicates a widening of the scope of the journal, though the scope has long transcended the limits implied by the title now discontinued. All who know the journal in its old form will wish it success under its new title and auspices.

Indian Association for the Cultivation of Science

THE annual report for the year 1947–48 of the Indian Association for the Cultivation of Science covers the year ending March 31, 1948, and in addition to the usual financial statement and balance sheet there are appended lists of books added to the library during the year, periodicals received by subscription or exchange, members of the Council and of the Committee of Management and a report on the scientific work of the Association. In the latter Prof. K. Banerjee reports on R. K. Sen's continued study of the extra Laue reflexions of benzil, while over-exposed Laue photographs of pyrene have been taken by M. N. Dutta at 30–100° C. which show that the intensities invariably increase with temperature for all the different spots. M. Ganguly has found that very clear reflexions of the low-angle scattered X-radiation can be obtained by a crystal which is very slightly mis-set from the position for reflecting the direct beam. B. S. Basak has undertaken the complete determination of the structure of phenanthrene crystals by the Fourier analysis method, and, with A. K. Rai Choudhury, has made X-ray diffraction studies of beryllium – aluminium and tin – aluminium systems. X-ray studies of samples of Indian coals have been made by N. N. Gupta, and the mechanism of the formation of jutellite, a plastic from jute waste, is being studied by J. C. Maitra. B. K. Banerjee has continued to study the dispersion of metals and salts in glass, and Dr. A. Bose has undertaken a systematic investigation of crystal paramagnetism to determine whether group structure formed by the internal fields in the solid state persists in solution. A. Dutta has undertaken a systematic study of the magnetic and electric properties of semiconductors, such as tungstenite.

Prof. S. C. Sirkar reports on B. M. Bishui's investigation of the polarization of Raman lines of ethylene dibromide in various solvents and on his further work on the Raman spectra of 1 : 1-dichloroethane. The Department of Physical Chemistry only commenced work on October 1, 1947, but Prof. S. R. Palit reports that investigation has already been initiated on several problems in polymerization, on surface-active agents and metallic soaps in organic solvents with reference to solubility, surface tension, electrical and similar properties, on the kinetics of halogenation of sodium acetate in glacial acetic acid, sodium propionate in propionic acid, etc. Potentiometric studies in non-aqueous media have also been undertaken, as well as the synthesis of styrene, methyl methacrylate, etc., for high-polymer studies.

New York Academy of Medicine

Now that Great Britain is committed to the National Health Service, it is interesting to find that neither the retiring president of the New York Academy of Medicine, nor its incoming president, nor the Academy itself, can support, at present at any rate, compulsory national medical insurance in the United States. Dr. George Baehr, the retiring president, referred, in his valedictory address to the Academy delivered on January 6 last, to the report, published in 1947, of the four-year study made by the Academy's Committee on "Medicine and the Changing Order". He reminded his audience that the Academy recognizes the need for changes; but, after serious consideration, has decided definitely to oppose compulsory national medical insurance at the present time. Instead, it considers that a medical service with prepayment of fees can be attained more efficiently and with much less risk by Federal grants to State and local areas; such a service would be adaptable to the varying needs of the States and their political subdivisions and also to rural and urban areas. The Academy favours voluntary efforts because they are more flexible and experimental; but it should consider earnestly the effects upon medical practice, education and research of the modern prepayment schemes. A new Committee of Medicine and the Changing Order has been appointed to consider this question. Dr. Baehr also referred to the success of the new (twelfth) Microbiological Section of the Academy and to the great services performed by the Library, which is one of the largest in the world.

Dr. B. P. Watson, the incoming president, has spent most of his life as a teacher and thus becomes the head of an educational institution devoted to the needs of the medical profession, the layman and the community as a whole. He reminded his audience that present-day medicine is the result of a slow process of evolution, in which the scientific approach to medicine has played a part since "the beginnings of recorded time". This evolution is the result of the interplay between research workers, reactionaries opposed to change, extremists who wish to proceed too quickly and the backbone of the profession, composed of steady, experimental thinkers who await the results of experiments and give the individual and the community the best that the profession can offer. Dr. Watson felt that any plans for a compulsory national health insurance that could be instituted now would lower the quality of medical care provided and would give the individual medical practitioner a task that he could not perform with satisfaction either to himself or to his patients. The Academy recognizes the need for improvement in the distribution of medical care, so that everyone can have it, but it pleads for continuing study and development, so that the best medical service and better teaching and research may result. In the course of his address, Dr. Watson discussed medical education, emphasizing, as the Goodenough Report on British Medical Schools has done, the teaching of principles, the integration of details learnt and the infusion into the teaching of more of the philosophical thought bequeathed to us by the past and nowadays "forgotten in the hectic pursuit of each newly-discovered fact".

Forestry in Uganda : Report for 1947

The annual report of the Forest Department of Uganda Protectorate for the year ended December 31, 1947, has recently been published (Entebbe: Govt. Printer, 1948; price 2*s*. 6*d*.). This report of 49 pages commences, as a number of recent forest reports from Africa have done, by a declaration of Government forest policy, which is on the familiar lines that have often been referred to in *Nature* in connexion with forestry notes. The forest policy during 1947 was considerably implemented as the report shows; it was to some extent the result of the Development Plan for Uganda put forward by Dr. E. B. Worthington which was approved by the Legislative Council during the year. This plan provided for the Forest Department receiving the sum of £205,500 to be spent in the ten years 1947–56 on expansion and development schemes, and this sum was to be in addition to the ordinary normal recurrent expenditure. As the amounts to be spent from this allocation for work only included soft-wood timber plantations, fuel planting-schemes, and research and investigation, hardwood-timber planting schemes apparently are to be covered by normal recurrent expenditure. This appears to be a pity, since it would seem that the indigenous hardwoods of Uganda may be neglected. Anti-malaria plantations were formed, at the request of the medical and health authorities, and the Department meant to clear-fell and replant them at intervals as an addition to the fuel supplies; but the health authority has been against clear-felling, and the plantations will be managed on the selection felling basis. The reservation of more forest has been proceeding, but it is pointed out that the distribution of forest is not all that could be wished for, particularly in parts of the Eastern Province; nor is it hoped to be able to make further reserves, and this leaves one with village forests as the alternative. It is noteworthy in this report that the importance of the savannah forest has now come to be understood. In fact, it is stated that the greater part of Uganda is covered by this type of forest growth, and it is from the savannah rather than from closed forest that the demands of people for forest produce are chiefly met. It is a welcome sign that the formerly neglected savannah or 'bush' is now coming into recognition and, even more, that it is to be classified as 'forest'.

Hormones and 'Drop' of Apple Fruits

The abscission or dropping of apple and other fruits after fertilization is sometimes a valuable natural method of thinning the crop, but is often the source of much loss of fruit. L. C. Luckwill has studied the relation to this 'drop' of a hormone occurring in apple seeds (*J. Hort. Sci.*, 24, No. 1, 32; June 1948). He devised a quantitative method of measuring the hormone extract by treatment of tomato ovaries (*ibid.*, 19) and was able to show that the appearance of the hormone in the seed coincided with cessation of the post-blossom drop. In the variety Beauty of Bath, the hormone appeared 25–30 days after petal-fall. Seeds of nearly ripe apples had little hormone, and its disappearance corresponded with the occurrence of pre-harvest dropping of the fruit. Moreover, seeds from 'June-drop' fruitlets of two other varieties contained much less hormone than those of fruits which remained on the tree. This hormone can be extracted from the seeds with boiling water, and though it stimulates the development of tomato ovaries, it does not appear to initiate fruit growth in the apple. It does, in fact, appear to be concerned chiefly with the control of fruit drop.

Markle Foundation Scholarships in Medicine

Under the plan begun in 1948 by the John and Mary R. Markle Foundation to assist qualified men and women wishing to remain in academic medicine, thirteen men of science have been awarded grants of 5,000 dollars a year, for five years, to maintain them in the medical schools of the United States and Canada in which they now hold faculty appointments. So far, twenty-nine such awards have been made. The thirteen new recipients, their fields of interest, and place of present appointment are as follow: Dr. Francis P. Chinard (University of California and Johns Hopkins), clinical chemistry and physiology, at Johns Hopkins University; Dr. Don W. Fawcett (Harvard), microscopic anatomy, at Harvard Medical School; Dr. Allan V. N. Goodyer (Yale), internal medicine and cardiovascular disease, at Yale University; Dr. John B. Graham (Cornell), pathology, at the University of North Carolina; Dr. John D. Green (Oxford), anatomy and physiology, at Wayne University College of Medicine; Dr. George Watson James, III (Washington and Lee University), internal medicine and physiology, at the Medical College of Virginia; Dr. Ralph Jones, jun. (West Virginia

University and University of Pennsylvania), clinical therapeutics, at the University of Pennsylvania; Dr. George E. Moore (University of Minnesota), surgery and onocology, at the University of Minnesota; Dr. C. Barber Mueller (University of Illinois and Washington University), surgery and biochemistry, at Washington University; Dr. George W. Schwert, jun. (University of Minnesota), physical biochemistry, at Duke University; Dr. Beverly T. Towery (Vanderbilt), internal medicine and endocrinology, at Vanderbilt University; Dr. W. Clarke Wescoe (Cornell), pharmacology, at Cornell University; Dr. Donald R. Wilson (Oxford and McGill), internal medicine and endocrinology, at the University of Alberta.

Scholarships in the United States for British Students

THE Colorado School of Mines is offering a scholarship to a male student from England for the academic year 1949–50. A separate offer is being made for Scotland. The scholarship is worth 425–475 dollars and is renewable for a maximum period of four years. Further particulars and application forms may be obtained from the Assistant Cultural Officer, U.S. Information Service, American Embassy, 5 Grosvenor Square, London, W.1, or from the secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, with whom application forms must be lodged by May 1.

Harvard University announces that a fellowship, worth 2,000 dollars, provided by Mrs. Frank Knox in connexion with the Frank Knox Memorial Foundation, will be made available to enable a student from the British Isles to spend the academic year 1949–50 at Harvard. The fellowship is open to students of all stages; but preference will be given to candidates who have graduated or are about to graduate in Great Britain or Ireland. There is no form of application. Further particulars can be obtained from the Secretary, Association of Universities of the British Commonwealth; applications must be completed by April 9.

International Conference on Science Abstracting

AN International Conference on Science Abstracting is to be held by Unesco in Paris during June 20–25. All Unesco and United Nations Member States will be entitled to nominate three delegates. Representatives have also been invited from the specialized agencies of the United Nations and from the appropriate international organisations such as the International Scientific Unions, the International Federation for Documentation and the International Organisation for Standardization. It is expected that the directors and editors of many of the most important abstracting services will be present at the Conference. Unesco will be glad to receive applications from persons other than officially appointed representatives who wish to attend as observers. The purpose of the Conference will be: "to consider and take action to improve and develop abstracting services for the natural sciences, both pure and applied, and to consider methods of increasing their usefulness to scientists, with regard at the same time to the related problems of indexing and accessibility of the recorded publications".

The Physical Society: Seventy-fifth Anniversary Celebrations

THE celebration of the seventy-fifth anniversary of the Physical Society will take place on March 21. A conversazione will be held in the Royal Society's Rooms, Burlington House, Piccadilly, London, W.1, during 8–11 p.m., with the president, Prof. G. I. Finch, and Mrs. Finch as hosts. Admission is by ticket only. Earlier in the day, at 5 p.m., the Guthrie Lecture will be delivered by Prof. A. O. Rankine at the Royal Institution, 21 Albemarle Street, London, W.1, the subject being "Experimental Studies in Thermal Convection".

Announcements

MAJOR-GENERAL CYRIL LLOYD, director of Army Education, has been appointed administrative director of the Department of Technology of the City and Guilds of London Institute as from October 1, in succession to Lieut.-Colonel W. French.

A DAVID ANDERSON BERRY Silver-gilt Medal with a sum of £100 will be awarded in 1950 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Applications (with copies of accomplished work) must be sent to the General Secretary of the Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, by March 31, 1950.

THE Arnold Gerstenberg Studentship for 1950 is open to students in the University of Cambridge who have obtained honours in the Natural Sciences Tripos and who went into residence not earlier than 1944. The Studentship will be awarded for an essay which must be submitted before May 1, 1950; full details may be obtained from Mr. R. B. Braithwaite, King's College, Cambridge.

DR. K. C. EDWARDS, reader in geography, has been appointed professor of geography, and Dr. E. J. W. Barrington, reader in zoology, has been appointed professor of zoology in the University of Nottingham. Both these chairs have just been established.

THE British Institute of Management will hold the fifty-third in the 'Oxford' series of Management Conferences at Cliftonville during May 5–8. The form of the Conference has been altered, and the general purpose is to obtain a consensus of opinion among practising managers on certain fundamental and possibly controversial questions relating to the development of management, for the guidance of the Institute. Applications for tickets and all correspondence should be addressed to the Director, British Institute of Management, 17 Hill Street, London, W.1.

A BOOKLET entitled "The Tilgate Story" has been issued by Messrs. F. W. Berk and Co., Ltd., of Commonwealth House, 1–19 New Oxford Street, W.C.1. This deals in a general way with the firm's research work on soil sterilization, deficiencies of soil nutrients, mercurial seed dressings, mercurized turf sand for the control of moss, and other mercury and copper fungicides and insecticides.

Mathematical Tables and Other Aids to Computation is a quarterly journal which is published and subsidized by the U.S. National Research Council. Not only is it running at a loss, but also costs are rapidly mounting. A substantial increase in the number of subscribers is necessary in order to avoid either increasing the price or reducing the size of the journal. The subscription-rate is 4 dollars per year, and full details may be obtained from the National Research Council, 2101 Constitution Avenue, Washington 25, D.C. In Great Britain the rate is 25*s*., and the agent is Scientific Computing Service, Ltd., 23 Bedford Square, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Heavy Nuclear Splinters

An extensive analysis[1] of the energetic disintegrations produced in the silver and bromine nuclei of nuclear emulsions exposed to cosmic radiation indicates that the emitted particles, consisting of α-particles, protons and neutrons, generally escape from the nucleus after the excitation energy has been statistically shared among the constituent nucleons.

The disintegration process is then analogous to the evaporation of molecules from a drop of liquid. Occasionally, however, stars are observed[2-4] in which highly charged nuclear splinters are ejected from strongly excited nuclei before equilibrium has been attained. From a total of six thousand stars, we have observed two examples in which we can identify such heavy fragments. These events are not so rare as this might imply, since their tracks can only be identified when they have a considerable length in the emulsion. The two stars were obtained in 'sandwich' emulsions exposed on the Jungfraujoch (3,500 m.).

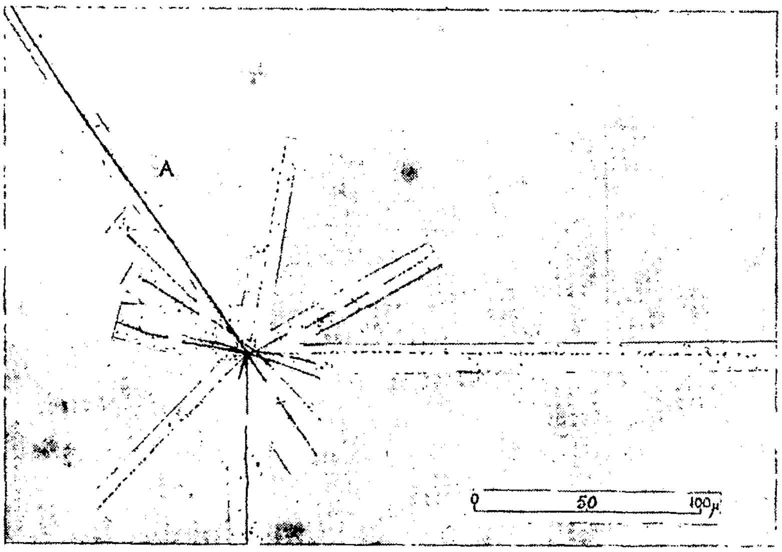


Fig. 1. Complete disintegration of a bromine nucleus, with emission of a heavy fragment of $Z = 11 \pm 1\ e$. Observer: Miss J. Steward

Fig. 1 is a photomicrograph of a large 'double star' in which at least eighteen charged particles are emitted. The heavy track *A*, $195\,\mu$ long, tapers towards the end of its range due to a gradual loss of charge as the nucleus picks up electrons. The 'thin-down length' is about $65\,\mu$, indicating[5] a charge of $11 \pm 1\ e$. The energy of the particle producing this track is estimated as 325 ± 50 MeV., and its momentum as $3{,}500 \pm 400$ MeV./*c*.

A second heavy particle emitted in this event either splits up spontaneously, or disintegrates a nucleus, after traversing $6\,\mu$ of emulsion. Assuming the former, its charge is at least $6\ e$, as two protons and two α-particles are emitted in this secondary event. Since, in addition, eight protons and five α-particles leave the parent nucleus, the charge of the latter must have been at least $35 \pm 3\ e$. It seems likely, therefore, that this event represents the complete disintegration of a bromine nucleus.

The background grain-density is very high in this plate, so the fainter proton tracks have been retouched in the photograph to make them easily visible. The emulsion contains $5\,\mu$ layers of pure gelatine, causing discontinuities in the tracks where the charged particles pass through these sandwich layers.

The second disintegration (see Fig. 2) was observed in an emulsion containing thin layers of lead phosphate, and coated on a 250-μ acetate base. This film was one of a pile, and the heavy particle from the star penetrates the last three films of the stack. Its equivalent range in emulsion is at least $2{,}000\,\mu$. A comparison of its δ-ray frequency with that along the track of a fast α-particle of known energy indicates that it is of charge $5 \pm 1\ e$ and hence energy 350 ± 100 MeV. and momentum $2{,}500 \pm 600$ MeV./*c*.

If we assume that the energy of the emitted neutrons is about equal to that of the protons, then the excitation energy required to produce these stars is estimated as at least 700 MeV. in the first case and 500 MeV. in the second. The apparent resultant momentum in each star is approximately 3,000 MeV./*c*, and is directed downwards, assuming the distribution of the neutrons to be roughly isotropic.

The primary particles responsible for these two stars leave no apparent tracks in the emulsion, and so must have charge less than three, since the smallest

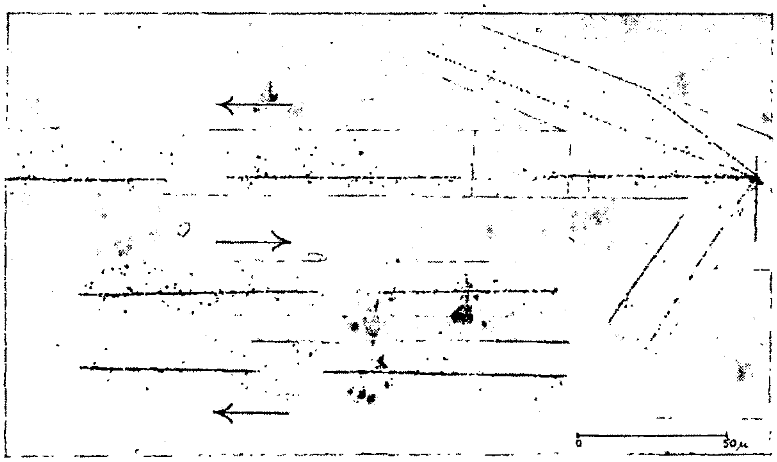


Fig. 2. Nuclear disintegration in which a heavy particle penetrating three films is emitted. The separate mosaics are sections of the tracks in three successive films. Observer: D. H. Perkins

ionization observable in Ilford $C.2$ plates is approximately six times minimum. In order to carry this momentum with a moderate mass, they must be moving with relativistic velocities. Hence the energy transfer, of the same order as the momentum transfer, is very large compared with the estimated excitation energy. The remaining energy can be accounted for either by assuming the isotropic emission of several very energetic neutrons, or perhaps by multiple meson production.

Note added in proof. Since communicating this letter, Dr. G. P. S. Occhialini has sent us details of a taper track similar to the one shown in Fig. 1. See Bonetti, A., and Dilworth, C., Bulletin de l'Université Libre de Bruxelles Note No. 7, January 1949.

P. E. HODGSON
D. H. PERKINS
Imperial College of Science
and Technology, S.W.7. Jan. 31.

[1] Harding, Lattimore and Perkins, *Proc. Roy. Soc.* (in the press).
[2] Heitler, Powell and Fertel, *Nature*, **144**, 283 (1939).
[3] Lovera, G., *Ric. Sci. Ricostruz.*, **17**, 2045 (1947).
[4] Schopper, E., *Naturwiss.*, **34**, 118 (1947).
[5] Freier, Lofgren, Ney and Oppenheimer, *Phys. Rev.*, **74**, 1818 (1948).

Cross-Section for Nuclear Disintegration Produced by Cosmic Rays

IT has been suggested[1] that the cross-section for star production is proportional to the geometrical cross-section of the nucleus. In order to establish this by direct experiment, we have exposed some 'gelatin sandwich' plates for fifty days at a height of 3,650 m. These plates consist of four layers of Ilford $C.2$ Nuclear Research emulsion, 30 μ thick, separated by three thin layers of plain gelatin. This sandwich emulsion, coated on an acetate base, was supercoated with a 5 μ gelatin layer. A second batch of plates with emulsion layers of 25 μ was exposed for forty days. In order to determine the thickness of the gelatin layers (excluding the supercoat) relative to the normal emulsion, we have measured the ratio of the projections in the plane of the emulsion of track length to gap length for those tracks which pass right through the sandwich emulsion. The gaps in the tracks occur when the ionizing particles pass through the gelatin layers. From these measurements on 300 tracks of length greater than 200 μ we conclude that in the plates so far examined the mean gelatin thickness : mean emulsion thickness equals 9·2 per cent.

Stars formed in the emulsion proper can arise through the disintegration of any of its constituent nuclei (silver, bromine and light nuclei), while those formed in the gelatin layers must be due to the disintegration of carbon, oxygen or nitrogen. A charged particle passing through gelatin will not produce a developable track. Hence the latter group of stars are easily recognized as their centres are not visible. From the careful scanning of 94 sq. cm. of these plates we have so far observed

$$\frac{\text{No. of gelatin stars}}{\text{No. of emulsion stars}} = \frac{30}{516} = 5{\cdot}8 \pm 0{\cdot}7 \text{ per cent.}$$

The error quoted is the probable error on the number of stars obtained in the gelatin layers (excluding the supercoat).

We will now assume an effective cross-section for star production proportional to the nuclear cross-section, which we take proportional to $A^{2/3}$. Let ρ_r be the concentration in gm./c.c. of the rth component of atomic weight A_r; suffixes E and G are used to denote emulsion and gelatin respectively. If N is Avogadro's number

$$\frac{\text{Number of gelatin stars}}{\text{Number of emulsion stars}} = \frac{\sum\limits_{rG} \dfrac{N\rho_{rG}}{A_{rG}} A_{rG}{}^{2/3}}{\sum\limits_{rE} \dfrac{N\rho_{rE}}{A_{rE}} A_{rE}{}^{2/3}}.$$

From the composition of the emulsion and gelatin layers, as quoted by the manufacturers, and from the area of plates scanned, we calculate this ratio to be 4·53 per cent.

Experimental results therefore indicate that the ratio of the cross-sections for star production in light and heavy nuclei is greater than the ratio of their nuclear cross-sections. The results obtained indicate that in normal emulsion 36 ± 4½ per cent of stars are due to disintegration of light elements instead of 27 per cent as calculated from an $A^{2/3}$ law.

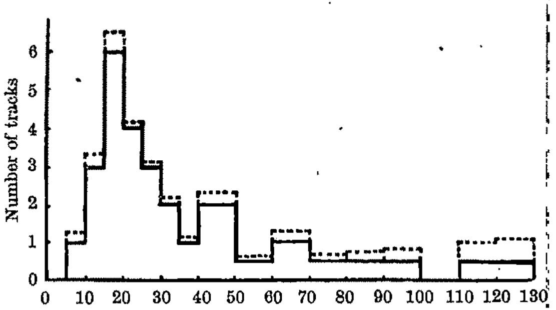
Analysis of gelatin stars. It is clear that large stars cannot be produced in the gelatin, for only light nuclei are present. The largest stars so far obtained in this laboratory have five prongs, one of which corresponds to the complete disintegration of oxygen into three α-particles, two protons and neutrons. The observed numbers of 2-, 3-, 4- and 5-pronged stars are 4, 16, 8 and 2 respectively. In so far as the statistics allow, this size distribution is seen to be similar to the one observed for the small stars (less than six prongs) in normal emulsion[2].

It is extremely difficult to distinguish between the track of an α-particle (less than 50 MeV.) and that formed by a heavier particle such as lithium or beryllium. In the gelatin stars we have observed a total of fifty-five singly charged particles and forty-three having at least two charges. Assigning a charge of exactly $2e$ to each of this latter group, we find the average charge permitted per star is $4{\cdot}7\,e$, which is about $2e$ less than the average nuclear charge. This 'loss' of charge might be accounted for in three ways : (1) by the ejection of very fast singly charged particles which do not leave visible tracks in the emulsion ; (2) by the ejection of a group of charged particles of short range, the majority of which remain in the gelatin layer ; (3) by assigning more than two charges to a number of the heavily ionizing particles.

At present we cannot estimate the effect of process (1) ; but experiments with electron-sensitive emulsions should enable us to obtain the number of very high energy particles ejected per star.

Regarding the second process, it may be noted that in normal emulsion only one third of the small stars have tracks of less than 10 μ (average range, 5 μ)[3]. If all these come from light nuclei, which seems improbable, a maximum of about one track of short range is produced per light disintegration. The stopping power of gelatin is about half that of normal emulsion, and so such tracks should have a mean range of 10 μ in gelatin. The probability of a track of length l remaining in a layer of thickness d is $d/2l$. Hence with d, the thickness of the gelatin layer, equal to 3·6 μ, the probability of a track of 10 μ remaining in the gelatin is about one-fifth. Thus four-fifths of such tracks should pass into the emulsion, and we might reasonably expect to see half of these. As yet we have not observed any. It therefore seems that the estimate of one short track per star is far too high (possibly by a factor of 3). We think it is unlikely that even an average charge of $\frac{1}{2}e$ could escape detection, due to the thickness of the gelatin layer.

It therefore seems probable that about half the heavily ionized tracks are formed by particles having a charge in excess of that carried by an α-particle.



The range distribution of the complete heavily ionized tracks is shown in the accompanying histogram, which has been corrected for loss of tracks due to (*a*) those remaining in the gelatin layers, (*b*) those which pass out of the emulsion. The corrected distribution is shown by the dotted curve.

This work is being continued, and will be reported more fully upon completion.

J. B. Harding

Imperial College of Science and Technology,
London, S.W.7. Jan. 25.

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[1] George, E. P., *Nature*, **162**, 333 (1948).

[2] Thomson, G. P., Bakerian Lecture Roy. Soc., 1948.

[3] Harding, J. B., *Phil. Mag.* (in the press).

Structure of Molecular Films of Stearic Acid on Copper

Electron diffraction patterns obtained during an investigation of the effect of temperature on mono- and multi-molecular layers of stearic acid on copper have produced evidence for the existence of crystallites of a metal soap on the copper surface.

The layers of acid were deposited by the Langmuir–Blodgett method[1] on a metal surface which had been finely polished with rouge on 'Selvyt', degreased electrolytically and rinsed in distilled water. Three or more layers give diffraction patterns at 20° C. consisting of strong grease bands (Fig. 1), corresponding to the different orders of the 2·54 A. alternate carbon-to-carbon spacing in the hydrocarbon chain. On raising the temperature of the metal support, the bands gradually fade. At 80–85° C., while the band pattern is still visible, continuous rings corresponding to spacings of 3·76, 4·17 and 4·38 A. appear (Fig. 2). These rings increase in intensity with temperature, and at approximately 100° C. begin to arc. Further faint rings appear, until, at 115° C., there is a strong cross-grating pattern (Fig. 3). The pattern persists until at a temperature of 127–130° C. it fades suddenly, leaving a diffuse background.

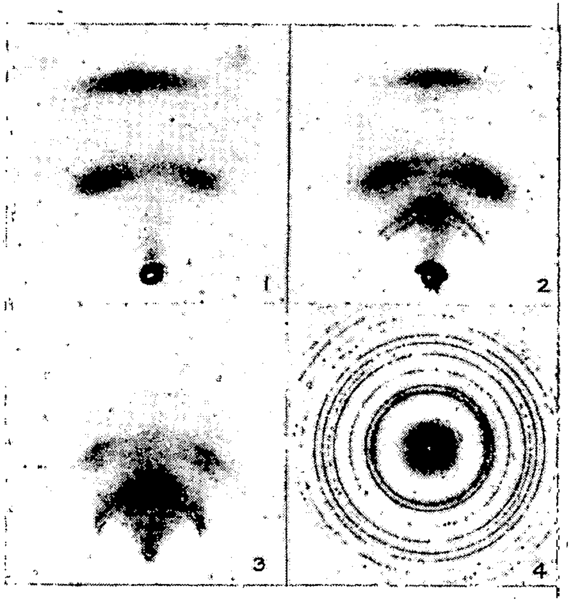

Fig. 1. Reflexion pattern of 7 layers of stearic acid on copper at 20° C.
Fig. 2. Same, after heating to 95° C.
Fig. 3. Same, after heating to 115° C.
Fig. 4. Transmission pattern of copper stearate dissolved from copper surface

The obvious conclusion, that the rings are due to the appearance of copper stearate, was confirmed by comparison of the planar spacings with those obtained from transmission patterns of a copper stearate powder prepared in the laboratory. When a specimen giving the pattern shown in Fig. 3 is boiled for several minutes in pure benzene, the subsequent solution after evaporation on a collodion support gives a strong transmission pattern (Fig. 4). The strongest two rings correspond to spacings of 3·76 and 4·17 A.

From these observations it would appear that at some temperature below 80° C. the stearic acid begins to melt (if one can speak of melting in such layers), reacts with the copper and forms copper stearate. (The bulk melting point of stearic acid is 69° C.; copper stearate softens at approximately 125° C. The effect of the metal surface on the melting point of molecular layers of such compounds is being investigated.) The stearate gradually collects into discrete crystallites, projecting from the metal surface and showing some preferred orientation. The pattern indicates that the crystals are oriented with their (001) plane parallel to the metal surface. At 130° C. the crystals melt.

Further experiments, however, indicate that, if the multi-layers on copper are allowed to age for some days, similar crystallites are obtained at temperatures well below the melting point of stearic acid. Melting of the acid apparently merely accelerates the reaction and subsequent crystallization.

Reaction between molecular layers of polar compounds with the underlying metal or metal oxide surface has been proposed by previous workers[2-4]; but no definite electron diffraction evidence of the existence of the products of such reactions has previously been reported. The conception of the crystallization of multilayers of long-chain compounds is not a new one. Coumoulos and Rideal[5] reported in 1941 that molecular layers of long-chain esters on nitrocellulose supports crystallized on ageing.

Further work on other metals is in progress.

My thanks are due to Dr. A. L. G. Rees for permission to use the electron diffraction camera of the Chemical Physics Section, Division of Industrial Chemistry, and for his constant advice and criticism. The work forms part of the general programme of research of the Tribophysics Division of the Council for Scientific and Industrial Research.

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[1] Blodgett, K. B., *J. Amer. Chem. Soc.*, **57**, 1007 (1935).

[2] Bowden, F. P., Gregory, J. N., and Tabor, D., *Nature*, **156**, 97 (1945).

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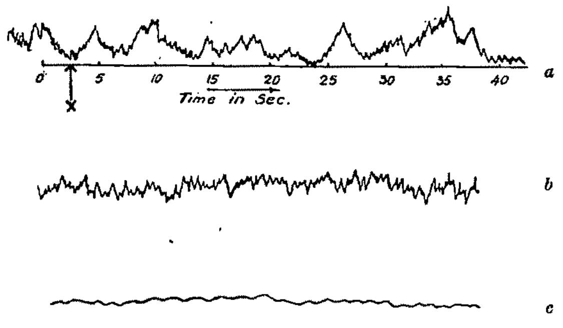
A Peculiar Type of Rapid Fading in Radio Reception

WHILE studying the field-strength variations at Waltair of transmissions from certain broadcasting stations of the All-India Radio, a peculiar type of rapid fading, which does not appear to have been reported so far, was observed during the summer months on the 41- and 60-metre bands. The phenomenon may briefly be described as the apparent existence on the carrier, at the receiving end, of a permanent modulation of 2–3 cycles per second. When the programme is on, there is superposed on it a variation in intensity at frequencies ranging between 2 to 3 cycles per second. This gives the impression of a quivering or fluttering of the transmission. This phenomenon is therefore referred to here as the 'flutter phenomenon'. The effect produced in the loud-speaker by the 'flutter' is somewhat similar to the beating of two notes of nearly the same frequency. When the quasi-frequency of the 'flutter' becomes large, it produces a most annoying effect, and listening to a programme becomes almost impossible. The effect is further accentuated by occasional large amplitude of the 'flutter'.

A study of the phenomenon with respect to the evening and night transmissions of All-India Radio (Madras) showed the following features: (1) It occurs only during the summer months. In 1948 it started about the second week of February and continued to the end of June almost every day. (2) The 'flutter' appears at about the period of sunset. The quasi-flutter frequency is low (about 20–30 c./min.) before sunset, but increases (to 120–140 c./min.) up to a point in the night and thereafter remains practically constant.

Although this effect was observed on the Madras transmissions, it was noticed on the 41-, 49- and 60-metre bands transmissions from other stations of All-India Radio as well, and occasionally on the 19-metre band. It is completely absent on the medium wave-band.



A trace of galvanometer records incorporated in a field-strength measuring equipment is given in the accompanying diagram: curve (*a*) refers to All-India Radio (Madras) on 41 metres; curve (*b*) to the Colombo transmissions on 61 metres; and curve (*c*) refers to the transmission of All-India Radio (Trichinopoly) on 396 metres. The curves were taken at 2000 and 2045 hr. I.S.T., on June 16, 1948.

It is seen from the curves that there is a slow fading with periods ranging from 3 to 4 sec. giving rise to what clearly appears as the usual slow type of fading, the signal strength fluctuating between 2,000 μV./m. to 200 μV./m. Superposed on this are the small, fine discontinuities which make the trace appear rugged. It is this rugged structure which is noticed as the 'flutter'. At the point marked *X*, the number of these discontinuities is 12 in a period of 5 sec., that is, it occurs at intervals of approximately 0·5 sec. or at a frequency of about 140 cycles per minute.

The rugged structure of the curves reminds one of the irregular scatter groups obtained by Eckersley[1] and the occurrence of flickering reflexions from the *F*-region reported by Beckmann, Menzel and Vibig[2]. A peculiar type of rapid fading (about 37 cycles per minute) was observed by Appleton and Beynon[3] during the period of sunset due to the reception of the Pedersen ray. The phenomenon described here is different from the above in that the rapid fading noticed by the above authors was only during a period of 14 min. passing through sunset; but the one described here commences about the period of sunset and persists over long periods. Therefore the ionosphere must in some way be responsible for the 'flutter' phenomenon, although the exact method of production of this effect is not known. If the rapid movement of the ionic clouds across the *F*-layer is a regular process as observed by Wells, Watts and George[4], the effect reported above may be produced by these clouds. The speed and the number of clouds that pass a given point in space may to a large extent determine the frequency of the rapid fading produced.

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[2] Menzel, Beckmann and Vibig, *T.F.T.*, **28**, 130 (1939).

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Tilting-Plate Compensators

THE various communications describing ingenious modifications of the tilting-plate compensator which have appeared in *Nature* in recent months suggest that a rather different form, which I improvised from a pair of selenite plates, might be of some interest, particularly as the special materials mentioned by previous contributors are not always immediately available.

The essential optical element of this compensator consists of a pair of optically identical birefringent plates, mounted one upon the other with their vibration planes mutually perpendicular. In consequence of the latter feature, their respective retarding powers are in opposition, but are equal in magnitude only for the special case of normal transmission, the total retardation then amounting to zero. For all other directions of transmission their respective retardations differ, resulting in a total retardation which increases as the combined plates are tilted away from the normal. Viewed normally between crossed Nicols in convergent light, the plates yield a conoscopic interference figure resembling that of a single plate of uniaxial material cut perpendicular to the optic axis. It is thus possible to construct a tilting optical element giving a zero retardation for normal transmission.

The advantage of this form of compensator is that the plates can be made from almost any birefringent material whatsoever, since the orientation of the optic axis or axes does not affect the mutual neutralization for normal transmission. The present optical element consists of two plates of selenite of 2·5 mm. thickness, giving a compensating range of about four wave-lengths; but mica would probably be preferable because it would permit of thinner plates. In the case of the most common form of mica, the normal bisects the acute angle of the optic axes, so that a pair of opposed mica plates have to be tilted through only a comparatively small angle to bring an optic axis of one of them into coincidence with the direction of transmission. When one of the mica plates is in this particular position, its retarding effect is zero, while that of the other will be rather greater than for normal transmission. Consequently, if each mica plate is of such thickness as to introduce a retardation of, say, four wave-lengths, a total retardation exceeding this value will be obtained when the plates are combined in opposition and tilted into the above position.

The calibration may be computed along the lines mentioned by F. Record[1], with the difference that there are two plates to be computed separately, each pair of values corresponding to a given angle of inclination being afterwards added to provide the calibration curve.

Mounting the two plates separately in such a manner that they can be tilted independently of one another suggests further possibilities which might be worth investigating.

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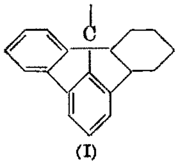
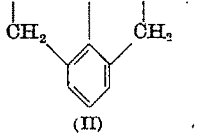
[1] *Nature*, **162**, 454 (1948).

1 : 9-*cyclo*Hexylenefluorene

Hurd and Mold[1] have recently described the dehydration of 2-fluorenyl*cyclo*hexanol to a saturated hydrocarbon to which they attribute the structure (I) of 1 : 9-*cyclo*hexylenefluorene. If this structure were correct, the result would be of considerable importance, for it would represent the first successful attempt to prepare a compound having the highly strained ring-system (II) which von Braun had completely failed to obtain[2].



(I)



(II)

It is very unlikely, however, that the hydrocarbon of Hurd and Mold has the structure (I). The dehydration of their carbinol is probably analogous to that of 2-benzyl*cyclo*hexanol, which gives a bridged ring hydrocarbon[3]. Experiments to test this hypothesis are being initiated.

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Sept. 18.

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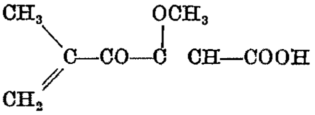
[2] See Johnson, W. S., "Organic Reactions", **2**, 124.

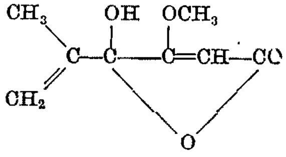
[3] Cook, J. W., and Hewett, C. L., *J. Chem. Soc.*, 62 (1936).

Tautomerism of Penicillic Acid

THE existence of tautomeric forms of penicillic acid was first postulated by Birkinshaw, Oxford and Raistrick[1]. Recent workers have tended to the view that the hypothesis of tautomerism was not needed to explain the chemical properties of penicillic acid[2].



(I)

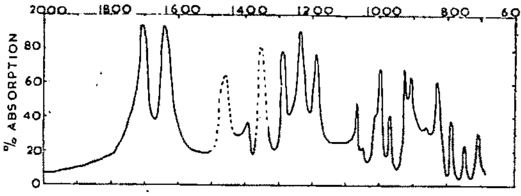


(II)

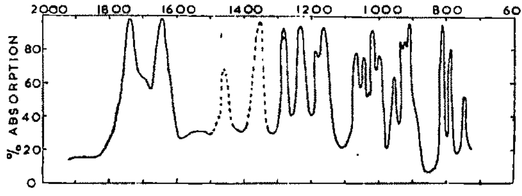
However, the infra-red spectra of penicillic acid furnish conclusive evidence for the existence, in the solid phase at least, of two tautomeric forms. The infra-red spectra of the two forms are shown in Figs. (i) and (ii). Spectrum (i), with carbonyl absorption band at 1,714 cm.$^{-1}$, is that of the keto acid (I); and spectrum (ii), with carbonyl absorption band at 1,738 cm.$^{-1}$, is that of the lactone form (II). Key bands for each form are:

Keto acid	1,714	1,393	967	831			cm.$^{-1}$
Lactone	1,738	1,165	1,032w	956	935	808	cm.$^{-1}$

The infra-red spectrum of the sodium salt of penicillic acid has been obtained. This contained no lactone carbonyl absorption band, but a powerful new band at 1,550 cm.$^{-1}$ was observed, indicating the formation of a carboxyl ion. It was concluded that the sodium salt was the salt of the keto acid and not an enolic salt.



(i)



(ii)

The two forms of penicillic acid can be readily interconverted. The lactone form was produced by melting the keto acid and allowing it to crystallize. It was also formed by prolonged grinding of the keto acid in 'Nujol'. When the lactone form was dissolved in ether and recrystallized, the keto acid was again produced. By suitable physical treatment, all types of mixture from 100 per cent form I to 100 per cent form II can be obtained.

A number of analogues of penicillic acid have been examined; but no further examples of tautomerism have been observed.

In view of the widespread use of the method of grinding in 'Nujol' for analytical work in the infra-red region, attention may be directed to the fact that in the case of materials existing in tautomeric forms with small energy differences, radical changes in the infra-red absorption spectrum can be produced by grinding. Prolonged grinding has been recommended[3] as a means of securing random orientation of the crystals in the absorption cells; but the possibility of changes occurring due to tautomeric interconversion should always be borne in mind.

A full account of this work will be published elsewhere. Thanks are due to Dr. R. A. Raphael for his kindness in supplying specimens of synthetic[4] and natural penicillic acid and their analogues, to Mr. L. Beecher for assistance with the experimental work, which was carried out for the Chemical Inspectorate, Ministry of Supply, at the Royal Arsenal, Woolwich, and to the Chief Scientist, Ministry of Supply, for permission to publish.

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[1] Birkinshaw, J. H., Oxford, A. E., and Raistrick, H., *Biochem. J.*, **30**, 394 (1936).

[2] Raphael, R. A., *J. Chem. Soc.*, 805 (1947).

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Oxidation of α-Diketones and α-Keto-Acids by Hydrogen Peroxide

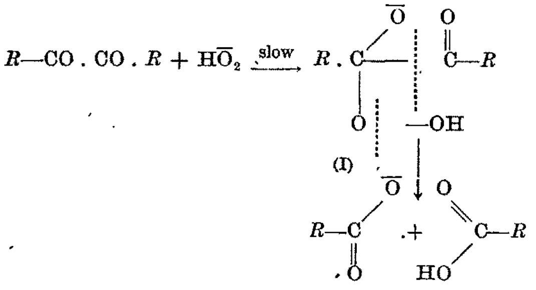
THE oxidation of α-diketones and α-keto-carboxylic acids by hydrogen peroxide involves the breaking of the carbon–carbon bond between the carbonyl carbon and the carbonyl or carboxyl groups[1].

R—CO . CO . R + $H_2O_2 \rightarrow 2R$—CO . OH ;

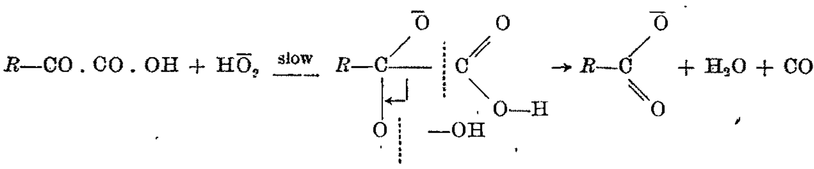
R—CO . CO . OH + $H_2O_2 \rightarrow R$. CO . OH + $H_2O + CO_2$.

This note discusses the mechanism of these reactions in the light of new experimental evidence, and in terms of suggestions I and my co-workers have previously made[2].

The kinetics of these oxidations have been studied in aqueous solutions, and a very marked base catalysis is observed. Such base catalysis is frequently found in the reactions of hydrogen peroxide, and it is considered to indicate a rate-determining attack by the hydroperoxide ion, formed by the ionization of the hydrogen peroxide. The reaction mechanism suggested for the reactions now considered involves the addition of this nucleophilic ion to the carbonyl carbon atom. The conclusion that the addition is rate-determining is in accord with what is known concerning additions of other nucleophilic anions, for example, the cyanide ion, to carbonyl groups.



(I)



(II)

The kinetics give little information as to the life of the intermediates, I and II, which probably have at most a transient existence.

The base catalysis is observed in the oxidation by hydrogen peroxide of diacetyl and sodium pyruvate, and also of benzil and sodium benzoylformate. Neither of these latter compounds can undergo enolization, and therefore this base catalysis cannot be explained by any mechanism which involves the enolization of the compound.

Mechanisms involving free radicals derived from hydrogen peroxide are also excluded under our experimental conditions. It is found that hydrogen peroxide in the presence of slightly acid ferrous or ferric salts, a recognized source of free hydroxyl radicals[3], does not readily decarboxylate benzoylformic acid. Furthermore, pyruvic acid can actually be prepared by the oxidation of lactic acid with ferrous sulphate and hydrogen peroxide[4].

A detailed account of this work will be published later.

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[1] Holleman, *Proc. K. Akad. Wetensch. Amsterdam*, **6**, 715 (1904).

[2] Bunton, Minkoff, *et al.*, *Nature*, **161**, 172 (1948).

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Demethylation of N : N-Dimethyl-*p*-Aminoazobenzene (Butter Yellow) with Hydrogen Peroxide

THE reaction which butter yellow undergoes with the Milas reagents[1] (hydrogen peroxide in *tert.* butyl alcohol with osmium tetroxide as catalyst) is being studied in detail to determine the extent to which it parallels the reaction occurring with this substance *in vivo*, since the *in vitro* reaction is accompanied by a chemiluminescence[2]. Miller and Miller[3,4] have recently given evidence that hydroxylation of butter yellow or its demethylated derivatives occurs to some extent in the rat, and, as it was expected that the Milas reagents would effect hydroxylation of the substance, they seemed suitable for the comparison. Separation of the reaction products, however, also showed that much of the action had taken place at the tertiary nitrogen atom. The following results have been obtained so far.

0·75 gm. of butter yellow, which had been previously freed from traces of the monomethyl compound and the free base by chromatography using an alumina column and petroleum ether (60–80° C.) as solvent and eluent, was dissolved in 270 ml. of an 8·1 per cent solution of hydrogen peroxide in *tert.* butyl alcohol, and 7 ml. of a 0·5 per cent solution of osmium tetroxide in *tert.* butyl alcohol was added to this. The mixture was maintained at 37° C. for 12 hours, since this was the temperature at which the chemiluminescence observations had been made. The alcohol solution was then diluted to 2 litres with water and extracted with 4 litres of benzene. The benzene extract was concentrated and passed on to an alumina column. After elution of the different zones and repeated chromatography of these, a large number of different eluates was obtained. The materials producing four of these zones were (*a*) 0·11 gm. unchanged butter yellow, (*b*) 0·13 gm. N-methyl-*p*-aminoazobenzene, (*c*) 0·013 gm. *p*-aminoazobenzene, (*d*) 0·013 gm. *p*-nitroazobenzene. The materials were identified by comparison of solubilities and colours in dilute hydrochloric acid, chromatographic behaviour and finally melting-points, with those of samples of known compounds. For the small fractions of *p*-aminoazobenzene and *p*-nitroazobenzene, absorption spectra provided confirmatory evidence. Another small fraction has been obtained which has acid and basic properties and would therefore seem to be a hydroxyl derivative of butter yellow or its demethylated products.

The remainder of the reaction products are still being investigated; but the reactions which take place at the dimethylamino-group seemed worthy of separate note. The removal of alkyl groups from aromatic tertiary amines is not uncommon in *in vivo* reactions; but little is known of the reaction mechanism and the process is simply referred to as 'dealkylation'. Studies with amine oxidase[5,6] show that a number of amines undergo oxidation at the carbon–nitrogen linkage in the presence of this enzyme, and the experiments of Hess *et al.*[7] on cyclic $>N.CH_3$ compounds containing a ketone or aldehyde grouping (derivatives of pyrrolidine and piperidine) afford examples of intramolecular oxidative demethylation. The reaction described above provides an example of oxidative demethylation of an aromatic tertiary amine, effected by hydrogen peroxide.

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[2] Anderson, W., *Nature*, **160**, 892 (1947).
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Methylation in the Study of Polynucleotides

ALTHOUGH detailed knowledge of the components of pentose nucleic acids is still incomplete, considerable effort over a long period has been directed towards the problem of the mode of union of the constituent nucleosides. It was early recognized that these units are linked through phosphoric acid residues, and the precise manner in which this takes place has been studied more recently by electrometric titration[1].

As regards the groups in the nucleoside radicals which are concerned in the structure of the polynucleotide, direct evidence that carbohydrate hydroxyl groups are involved is scanty. It is now known that all four nucleotides, isolated after mild alkaline hydrolysis of the pentose polynucleotide of yeast, possess phosphoric ester groupings at position 3 of the sugar residue, and the question has been discussed whether di-ester linkages exist between positions 2 and 3 or 3 and 5 of the different nucleosides making up the polynucleotide[2]. Since, however, yields of the nucleotides are always far below expectation, it cannot be assumed that all the nucleosides are esterified in this way, and an open mind must be kept regarding the precise parts played by the carbohydrate radicals and the phosphoric acid residues in the internucleosidic linkages.

It is clear, therefore, that a technique is required whereby uncombined carbohydrate radicals may be counted and identified, in order that a complete picture of the mode of linkage of the carbohydrate radicals may be obtained. Methylation of yeast nucleic acid has been investigated with this end in view, as mentioned by the late Prof. J. Masson Gulland[3]. Since his death, this work has been carried forward and is now briefly reported. Levene records that the use of Purdie's reagent[4] brought about decomposition of nucleotides and nucleosides at a greater rate than methylation. In the absence of experimental details concerning this breakdown, it was decided to attempt again to make use of this reagent for the methylation of the pentose polynucleotide of yeast.

Repeated treatment of a suspension in methanol of yeast nucleic acid purified by the method of Sevag, Lackman and Smolens[5] with methyl iodide and silver oxide resulted in the formation of approximately eight, and no more, methoxyl groups per statistical tetranucleotide, four of which were assumed to be located on the phosphoric acid residues, since they could be hydrolysed readily by boiling aqueous sodium hydroxide. It was found that if methylation was carried out at the boiling point, the product was pale brown in colour, was deficient in nitrogen and contained no methylamino groups. If, however, experiments were conducted with vigorous shaking at 25° C., methylation proceeded satisfactorily, giving a pale straw-coloured hygroscopic powder, soluble in water and methanol, but insoluble in methyl iodide, acetone and ether, and possessing eight methoxyl groups as before and also approximately six methylamino groups per statistical tetranucleotide.

The degree of success attained in these experiments must be judged, for the present purpose, according to the extent to which the state of combination of carbohydrate hydroxyl groups involved in the internucleosidic links has been altered during methylation. If the assumption, for which there is no real justification at present, be made that carbohydrate radicals are involved in all the internucleosidic linkages, the molecular weight of the methylated product is probably the most reliable criterion. Accordingly, molecular weights were determined by the method of Fletcher, Gulland and Jordan[6] before and after methylation, and it was found that the nucleic acid had suffered no appreciable degradation. The values of the molecular weights, estimated from measurements of the diffusion coefficients by making the same assumptions as those made by Fletcher, Gulland and Jordan[6], range from 10,000 to 12,000 for the nucleic acid before methylation, and from 13,000 to 15,000 after treatment. It is considered, therefore, that this method of investigation promises well to attain in some measure the object in view. Before it is possible to state exactly the nature of nucleic acid methylated in this way and to isolate and identify fragments of the molecule, a study must be made of the effects of the above reagents on simple constituents of the polynucleotide molecule. Work is in progress to this end and will be reported elsewhere.

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Gulland and Smith, *J. Chem. Soc.*, 338 (1947).

[3] Gulland, J. M., Symp. Quant. Biol., **12**, 101 (1947).

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Resonance and Molecular Structure

There is now sufficient evidence available from accurate measurements of molecular dimensions to state with a fair degree of certainty that the ideal hybrid bonds of quantum mechanics are only found where the symmetry of the bonded system is identical with that of the hybridized atomic orbitals. It would seem that the presence of any asymmetry caused the angles between the bonds to deviate from the ideal values characteristic of the symmetrical system. Since the deviations are generally quite small (though now well outside the possible limits of experimental error in favourable cases) it seems probable that these asymmetric systems are resonance hybrids, in which there are small contributions from structures usually ignored. Thus, it is possible to account for the observed facts in the methyl halides as follows.

We assume that the ψ-function of the molecule CH_3X can be written as a linear combination of three functions characteristic of the structures I to III below:

$$\underset{\text{(I)}}{CH_3{-}X} \qquad \underset{\text{(II)}}{\overset{+}{C}H_3\ \overset{-}{X}} \qquad \underset{\text{(III)}}{\overset{-}{H}\ CH_2{=}\overset{+}{X}}$$

there being three equivalent structures III. In symbols,

$$\psi = a_1\psi_{\text{I}} + a_2\psi_{\text{II}} + a_3\psi_{\text{III}}, \qquad (1)$$

where $a_1^2 + a_2^2 + a_3^2 = 1$.

The required data are summarized below

X =	F	Cl	Br	I	
[1] $\theta_{\angle HCH}$	111° 48′	111° 52′	112° 6′	112° 12′	
[2] k_{CH}	4·71	4·90	4·95	5·00	× 10⁵ dynes/cm.

The small variations are thought to be real. The decrease in the C—H stretching constant k_{CH} encountered in passing from iodide to fluoride suggests an increase in a_3 in (1) in the same direction; this would be expected from what is known of the relative powers of conjugation of the halogen atoms. Now if we assume that in the structure (1), in which $a_2 = 0$, the two single bonds from III are effectively distributed over a cone with vertical angle 120°, cylindrically symmetrical about the axis C_3, then the angle HCH in the hybrid will be less than the normal tetrahedral value, the increment increasing with a_3. If, in addition, we assume that the positive methyl ion in II is itself a resonance hybrid, with a small contribution from the trigonal sp_2 structure (which seems reasonable, since here there are only three bonds actively employed), then the angle HCH in II will be greater than normal. Clearly, the structure (I) in which $a_3 = 0$ will then also have HCH angles greater than normal. If now both a_2 and a_3 are non-zero, and a_3 increases with respect to a_2 in passing from iodide to fluoride, then all the facts can be explained.

As a second example, consider the anomalous fluorinated ethylenes. In both vinylidene fluoride and tetrafluoroethylene, the C=C stretching frequency is abnormally high[3]. Resonance with structures of the type $\overset{-}{C}H_2{-}CF{=}\overset{+}{F}$ will account for increased C—F stretching frequencies, but would lead simultaneously to a decrease in $\nu_{C=C}$. It has been found that the non-planar $=CH_2$ bending frequency can be used as a measure of the extent to which the above resonance occurs in substituted ethylenes[4]; the large effect observed in vinyl and vinylidene fluorides[3,4], if all attributable to this resonance, would certainly be associated with a decrease in $\nu_{C=C}$. The observed increase can only come from resonance with structures such as $\overset{+}{H}\ CH{\equiv}CF\ \overset{-}{F}$, which become of importance with the fluorides because of the high electro-negativity of fluorine. It is possible that the large negative increments in δ_{CH_2} are also partly due to structures of the above type, since it is known that δ_{CH} is smaller for C—H bonds adjacent to triple bonds. Further, such structures would diminish the angle FCF; there is some evidence[3] that in $CH_2{=}CF_2$ this angle is as small as 112°.

There are other cases where the same principle may be applied. Thus, in formaldehyde[1], resonance with the single-bond structure $\overset{-}{O}{-}\overset{+}{C}H_2$ accounts for the increase (of 3° 26′) in the angle HCH over the normal trigonal value of 120°, the argument being analogous to that used to explain the assumed decrease of the tetrahedral HCH angle in the resonance hybrid $\{CH_3{-}X,\ \overset{-}{H}\ CH_2{=}\overset{+}{X}\}$. In phosgene, the chlorine atoms favour resonance of the type $\{O{=}CCl_2,\ \overset{-}{O}{-}CCl{=}\overset{+}{Cl}\}$, which would leave the trigonal angle unaffected; actually a decrease is observed, ($\theta_{\angle ClCCl} =$ 117°)[5], which may be attributed to the presence of small contributions from structures $O{=}C{=}\overset{+}{Cl}\ \overset{-}{Cl}$.

In conclusion, it may be mentioned that there is some evidence to show that the directions of bonds may be inclined at an angle to the line joining the nuclei of the bonded atoms. This idea was developed in connexion with highly strained cyclic systems[6]; but it is possible that it is applicable to the cases discussed in this note.

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Radioactive Emanating Power and Ultrasonic Treatment

It seems in certain cases reasonable to suggest an influence of ultrasonic treatment on radioactive emanating power[1]. Ultrasound may bring about changes in a solid substance which involve changes of the emanating power, either by affecting the specific surface or the diffusion coefficient of the emanation in the solid phase. A change of the former property should be permanent or show remanence, whereas a change of the latter should be restored after ceasing ultrasonic treatment. It should thus be possible to conclude which of the two changes has occurred.

We have started a study of the effect of ultrasound on the emanating power of gels of metal oxide hydrates. A dilute solution of aluminium chloride was precipitated in the cold with ammonia in the presence of radium–thorium. The carefully washed precipitate was centrifuged, and dried for seven days above concentrated sulphuric acid. It was then placed in the open air.

Measurements were made by the streaming method for radium–thorium often described[2], which affords an almost instant reading of the relative changes in the emanating power. In order to measure the activity of the emanation, we used a modification of the ionization electrometer according to Zimens[3]. A Crystalab ultrasonorator, model SL 520, Fisher Scientific Co., with a maximum effect of 500 watts was used as ultrasonic source. The frequency was 1,500 kc. The sample was exposed to the ultrasonic waves through the thin wall of a glass tube, which was placed in the oil fountain.

The experiments so far made have shown an immediate increase in emanating power caused by the ultrasonic waves. Thus in a typical experiment we got an increase amounting to 26 per cent. The high value remained constant for an hour, after which a slow decrease might perhaps be observed. The increase depends on the sound effect. In another experiment we got an increase of 24 per cent, at a generator output of 100 watts, and this value increased gradually to 33 per cent, as the generator output was increased to 500 watts. It must be remembered that the efficiency in this simple but typical experimental arrangement can scarcely be ascertained. It is, however, quite low.

These preliminary experiments seem to indicate that treatment with ultrasound brings about a disintegration of the agglomerates of the aluminium oxide hydrogel. From experiments of an entirely different character, Sata and Naruse have come to a similar conclusion[4]. In our case, however, another interpretation is possible, namely, that the ultrasound may have an influence on the amount of water absorbed by the gel, thus causing a change in the emanating power[5].

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Some Pharmacological Properties of Sodium Ethyl, 3 : 3 Dimethylallylbarbiturate

Preliminary observations have shown that when sodium ethyl, 3 : 3 dimethylallylbarbiturate was administered to dogs and cats, it produced a marked stimulation of gastric and salivary secretion. The stimulation appeared to be of central rather than peripheral origin[1-3].

Further studies with this compound, No. 16-*A* (Eli Lilly and Co.), have disclosed that it possesses other powerful pharmacological properties not usually ascribed to barbituric acid derivatives. It appears that the actions of this substance are the exact opposite of the ordinary hypnotic barbiturates. The effects studied so far show that it causes a distinct rise in blood pressure even when given intravenously; it causes an immediate marked stimulation of depth and frequency of respiration, and the body temperature is sharply raised. In unanæsthetized animals, overdosage is associated with restlessness, muscular contractions and violent convulsions. The animal's temperament appears to change, so that it appears frightened and becomes bold and vicious. Sympathetic over-activity may be noted. Death occurs following convulsive episodes and may be due to spasm of respiratory muscles, since anæsthetic doses of ordinary barbiturates may increase the tolerance to five to six times the M.L.D. for unanæsthetized animals.

The M.L.D. for cats and rabbits is approximately six to seven mgm./kgm. when administered intraperitoneally or intravenously. Symptoms occur when doses of 3–4 mgm./kgm. are reached. Cats anæsthetized with pentobarbital will tolerate total doses of 50 mgm./kgm. given over four hours. An intravenous dose of 5 mgm./kgm. in such a preparation caused a rise of 36 mm. mercury in blood pressure, which rapidly returned to normal.

In unanæsthetized animals, respiration is markedly stimulated, and vigorous panting occurs for approximately three hours; the rate may reach 180 per min. The rectal temperature rises to 105–107° F. and may reach 112° F. at death.

The isolated gut suspended in Ringer's solution is first stimulated and then narcotized when total concentrations of 0·01 per cent of 16-*A* are reached. During the latter stage, the gut fails to respond to added acetylcholine or histamine, but the response rapidly returns after washing out the barbiturate solution.

The antagonistic action of this compound to ordinary barbiturates suggests that it may be used to overcome some of their undesirable effects, such as depression of respiration and blood pressure, and might be of value as an antidote to barbiturate poisoning. Preliminary experiments indicate that an anæsthetic mixture of 16-*A* and pentobarbital may be rapidly given intravenously to rabbits without causing respiratory paralysis.

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Colour Vision

HAVING read the article on colour vision in *Nature* of October 23, 1948, and having heard the spontaneous comments of a number of people who have read that article, I am under the impression that readers who were not present at the Brighton meeting have got a somewhat incorrect impression as to the true state of affairs so far as the rival theories are concerned.

In the first place, there appears to have been a misunderstanding as to the interpretation which should be placed on papers recently published by Prof. R. Granit in the *Journal of Neurophysiology*. It is clear that some readers of his paper have gained the impression that Prof. Granit has abandoned the polychromatic theory on the grounds that many, if not all, types of modulator, which he has found in the eyes of animals, might be built up from receptors of three types only: red, green and blue. Let us accept this suggestion in order to examine its implications more closely. By some physiological process of summation or inhibition, the details of which are at present unknown, a trichromatic arrangement of receptors co-operates to produce a number of different functional units, which are distributed fairly uniformly throughout the spectrum, and have somewhat narrower response curves than the receptors from which they are produced. Now the important point, so far as colour vision is concerned, is that such functional units exist, because it is with these that the polychromatic theory is primarily concerned.

With regard to colour-matching data, three incorrect ideas appear to be held by some supporters of the three-colour theory. The first is that a colour match is stable under a wide range of light and colour adaptation. This is contrary to recent experimental findings, because it is now known beyond all possibility of dispute that either a considerable increase of light intensity, or a marked decrease of light intensity, or the adaptation of the eye to a bright light, markedly alters certain colour matches. So also do variations in the size of the test field. There is a further point in this connexion. It used to be supposed years ago not only that one subject with normal colour vision would accept the colour matches made by another, but also that colour-blind persons would do so as well. It is now known, however, that none of these ideas is correct. Not only is it unusual for one subject to accept the colour matches of another, but also it is sometimes found that colour matches made on one day are unacceptable to the same subject on the following day. Moreover, it is true that certain colour-blind persons will accept the matches made by normal-sighted subjects; but this is not true of all types of colour blindness. The protonomalous trichromatic observer may be specifically mentioned in this connexion.

The fact that additive mixtures of red, green and blue radiations produce colours which are too desaturated for an exact match with the spectral colours is claimed to be explicable on the ground that no physical stimulus, particularly no green stimulus, is capable of stimulating only one receptor; that is, that the sensitivity curves are broad ones, overlapping to some considerable extent in the spectrum. Two points should be noted in this connexion: first, that no confirmatory evidence has so far been produced for the statement that the sensitivity curves are broad ones; and secondly, that such an assumption is found to lead to erroneous conclusions so far as certain types of colour blindness are concerned. Thus the failure of additive mixtures to match spectral colours has still to be satisfactorily accounted for on the three-colour theory.

The article in *Nature* of October 23 mentions the point that even if there were a yellow receptor, the sensation of yellowness could not uniquely be associated with its stimulation, on the ground that yellowness can also be produced by a mixture of red and green radiations, and therefore by the combined activity of the red and green receptors. This may indeed be the case; but even if true, it does not throw doubt on the existence of independent yellow receptors. Two interesting points come up for consideration in this connexion. (1) On the basis of the three-colour theory, it would be expected that adapting the eye to yellow rays would produce identical results to those produced by adapting the eye under the same conditions to a red – green mixture which matched the yellow in hue, brightness and saturation; but as previously reported, experiment shows that such is not the case. (2) Certain trichromats with abnormal colour perception describe the yellow parts of the spectrum as 'red – green', that is, there is to them no specific yellow hue which to subjects with normal colour perception is so clearly different either from red or from green. This suggests the possibility that the yellow receptors may have some more specific function to perform than existing evidence indicates. With regard to the evidence for an independent yellow receptor, it is pointed out correctly that this cannot be based on the observation that a yellow pigmented surface is replaced by white when field size is altered. It is based principally on the following evidence: (1) experiments on monochromatic yellow light produced by a monochromator or by a screened sodium electric lamp; (2) the notches which occur in the luminosity curve for foveal photopic vision when light intensity is reduced, or field-size made small; (3) the adaptation experiments referred to above; (4) the disturbance of matches between pure yellow and a red – green mixture.

I would like to terminate these comments by briefly referring to some very recent work performed by Dr. L. C. Thomson. During an examination of the shape of the luminosity curve, when test fields of small size were being investigated, he found instead of a smooth curve, such as is obtained with fields of large size, that one was obtained which showed a series of small humps and depressions, there being a particularly clearly marked hump at a wave-length of $0{\cdot}42\,\mu$. Now it is especially interesting to note two other facts. First, Granit has recently discovered a modulator which has a crest very close to this wave-length. Secondly, I obtained evidence for a receptor with a crest at, or close to, this wave-length, which possessed a specific fixation point in the fovea, and also a characteristic subjective colour when the foveal centre was explored using the microstimulator apparatus.

The situation so far as the polychromatic theory is concerned may be summarized by saying that evidence is accumulating in its favour, and that the evidence in question is at variance with the three-colour theory. So far as can be judged at present, human foveal vision is approximately trichromatic, but it is also served by additional receptors which disclose their presence under appropriate experimental conditions. To-day it seems less a matter of discussion whether the three- or the poly-chromatic theory is correct, so much as to consider the spectral situation, the spectral distribution, and the retinal distribution of the additional receptors which are postulated by the polychromatic theory.

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Factors Influencing the Renal Threshold

It appears that threshold substances fall into two groups as regards their mode of tubular resorption. Glucose, xylose, phosphate, sulphate, amino acids and ascorbic acid on one hand have a definite Tm[1,2] value (maximal tubular resorption, mgm./min.) which is a measure of the active tubular cell-mass; the resorption of chloride and bicarbonate ions[3,4], on the other hand, is proportional to the quantity of glomerular filtrate.

The purpose of this note is to discuss the factors on which the threshold values of various substances depend, and to examine whether or not the difference in the resorption mechanism referred to above is reflected in the behaviour of the threshold.

For either group the value of the threshold Tx, mgm. per cent, of a substance x is such that

$$F_0 Tx/100 = Rx_0, \tag{1}$$

where Rx is the amount resorbed in the tubules (mgm./min.), F the rate of glomerular filtration (c.c./min.) and zero subscripts refer to values corresponding to the plasma concentration Tx. Evidently, for substances of the second group, where

$$100.Rx/F = \text{const.}, \tag{2}$$

$$Tx = 100.Rx/F \tag{3}$$

for any pair of values Rx and F[3,5]. This threshold is independent of the concentration of x in the plasma (Px) and of the actual values of Rx and F. It is a characteristic of the tubular function.

For substances of the first group

$$Rx = Tmx = \text{const.}, \tag{4}$$

for $Px \geqslant Tx$, and the formula of Földi *et al.*[6] can be used for the calculation of the threshold:

$$Tx = Px - \frac{P}{U}(Ux), \tag{5}$$

where P/U is the inulin concentration ratio and Ux the concentration of x in urine (mgm. per cent).

From (1), and putting $Rx_0 = Tmx$, we obtain

$$Tx = 100.Tmx/F_0. \tag{6}$$

It will be seen that, in this case, Tx is not a constant, but a function of Tmx and F_0. We have pointed out elsewhere[7] that Földi's formula can only be used if F is constant and independent of Px. It actually is so (as seen, for example, from Shannon and Fisher's data[1] for glucose), so that it is possible to write F instead of F_0 in (6). Thus, for substances having a threshold Tm,

$$Tx = 100.Tmx/F. \tag{7}$$

For every pair of values (Tmx, F), therefore, there is a threshold value $Tx_{(Tmx,\,F)}$.

Földi[8], in a recent communication, has expressed the threshold as

$$Tx = Px.Rx/Fx, \tag{8}$$

where Fx is the rate of glomerular filtration of x mgm./min., Rx is the rate of tubular re-absorption of x mgm./min., both being the values corresponding to the plasma level Px; and he has come to the conclusion that Tx is a function of the variables appearing on the right-hand side of (8). It would seem from the above discussion, however, that Tx is either itself a characteristic constant of the kidney, or a function of Tmx and F, as the case may be; but it is certainly independent of Px, the actual plasma concentration of x. Tx can, it is true, be calculated from Földi's formula, which involves Px, but the threshold is not a function of Px. We would clarify our point by a physical example: Boyle's law gives the equation of state for one mole of an ideal gas at constant temperature as

$$pV = \text{const.}, \tag{9}$$

where p is pressure and V is volume, and the constant is proportional to the absolute temperature. It is possible to calculate the constant from (9), but it cannot be said to be a function of the variables appearing in that equation. (8) is a precisely analogous equation between the variables Px, Rx and Fx, and the value of Tx is independent of the actual values of the variables, because it is constant for given values of Tmx and F.

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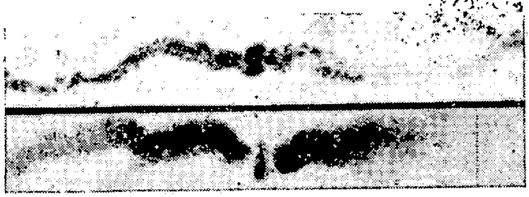
Nodes in the Central Nervous System

It is commonly stated that the nodes originally described by Ranvier[1], which are so characteristic a feature of peripheral nerve fibres, do not occur within the central nervous system. However, Ramón y Cajal, in his descriptions of those penetrating researches which have distinguished him as one of the foremost histologists of all time, refers repeatedly to *étranglements* or nodes on nerve fibres within the brain and spinal cord, and these are beautifully illustrated in some of his publications[2,3]. In spite of these observations, the absence of nodes in the central nervous system has often been assumed by some contemporary neurohistologists[4,5] and in many standard text-books of histology and neurology.

Recently, while examining several brains taken from rabbits injected intravenously with methylene blue, we have been able to confirm Ramón y Cajal's observations[6]. Deeply stained nodes, often associated with slight constrictions of the axis cylinder, have been found to be situated at intervals along tracts in many parts of the brain. Their morphological details are similar to those of nodes in peripheral fibres, including in some cases well-defined bracelets and cementing disks (see photograph). They are particularly conspicuous in fibres undergoing early degeneration, in which the axoplasm is metachromatically stained purple while the nodes remain a deep blue-



Nodes of small and large fibres in the optic tract, stained by intravenous methylene blue. (× 1,240)

green colour. In the central nervous system, as in peripheral nerve fibres, bifurcation invariably takes place at nodes, but many nodes are found in other situations. We have since found that similar preparations have been obtained with Ranvier's silver method by the late Prof. Zimmermann[7] of Bern.

Electrophysiological investigations of peripheral nerves recently made by Huxley and Staempfli[8] and Tasaki[9] have indicated, contrary to earlier opinions, that nodes play an important part in the propagation of nerve impulses. One of the main arguments hitherto adduced against this view is the supposed absence of nodes in the central nervous system. It appears that this objection can no longer be tenable. It is not clear how precisely the nodes of central fibres correspond to those in the periphery, because of the replacement of the Schwann sheath by oligodendroglia in the brain and spinal cord. However, unless the mechanism of nervous conduction differs greatly in different localities, nodes in the brain and spinal cord may have considerable physiological significance.

By the aid of intravenous methylene blue and silver methods, the structure and the distribution of nodes are now being studied with the view of obtaining anatomical data, for example, on the length of internodal segments, which have been pointed out[8] as relevant to the possible physiological role of node formations in the central nervous system.

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A Rare Species of Mysid from the Plymouth Area

When my husband, the late Prof. W. M. Tattersall, was examining material collected in the Plymouth area for his work on "The Seasonal Occurrence of Mysids off Plymouth"[1], he found a single adult male specimen from St. *L*.4 belonging to the genus *Heteromysis*. At that time only one species of this genus had been recorded from British waters, namely, *Heteromysis formosa* S. I. Smith. This species, though rare, had been recorded occasionally from Plymouth[2], the Channel Islands and from Scottish and Irish waters. As the male from Plymouth was undoubtedly a *Heteromysis*, it was not examined in detail but was recorded as *H. formosa*.

Shortly before his death in 1943, my husband had occasion to re-examine some of the Plymouth material, and found to his astonishment that the specimen he had recorded as *H. formosa* belonged to the much rarer *H. microps* (G. O. Sars)[3]. Sars first recorded his species under the generic name *Chiromysis*—"the mysis with a hand"—because of the very peculiar prehensile termination of the endopod of the third thoracic limb (= Sars's first leg). His material consisted of a few females only, from the Tunisian Gulf of Goletta, in 6–8 fathoms. Sars at the time was not aware that his new genus had already been described under the name of *Heteromysis* by S. I. Smith[4], who first recorded *Heteromysis formosa* from the North American side of the Atlantic, and he later withdrew the name *Chiromysis* in favour of the earlier *Heteromysis*[5].

Since Sars's original record of *H. microps* the species had never been recorded, nor had the male ever been seen until the specimen from Plymouth was taken. It was my husband's intention to publish a description of this unique specimen and, under his supervision, I made drawings of it. It agrees in the most minute detail with Sars's description and figures as regards general form, eyes, antennal scale, uropods and telson. The endopod of the third thoracic limb has the peculiar prehensile form which is the outstanding character of the genus, but in this specimen it is much more robust than in the females as figured by Sars. This is in all probability a sexual character.

In the hope of finding additional specimens of this interesting mysid, I recently spent some time at the Marine Laboratory, Plymouth, where, by kind permission of the director, Mr. F. S. Russell, I examined collections made in the neighbourhood of the original capture. Unfortunately, no other specimens of the species was obtained. A full description of the male, with figures, will be published shortly in a forthcoming Ray Society Monograph on the British Mysidacea.

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Pendeen, Heoldon,
Whitchurch, Glam.

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Photosynthesis in the Ears of Five Varieties of Wheat

In view of the observations of Knowles and Watkin[1], and of Watson and Norman[2], working with wheat and barley respectively, that about one-third of the final dry weight of the plant is added during the post-ear emergence period, the assimilation by the plant during this period merits special consideration as a factor in determining final yield. The concept of the net assimilation-rate, as originally proposed by Gregory[3], and so successfully used by him and others[4–6] in interpreting problems of crop-growth, would thus appear to require reconsideration, since the net assimilation-rate is usually estimated up to the stage of maximum leaf-growth. After this stage the proportion of green-leaf surface to that of other

	N.P. 710* $v1$	*N.P.* 165* $v2$	Punjab 9*D* $v3$	Agra Local $v4$	*N.P.* 735* $v5$	Significant differences at 5 per cent level
Days from sowing to anthesis	97	93	101	101	136	
Mean percentage contribution to grain-weight by assimilation in the ear	43·3 ± 3·31	15·3 ± 3·99	23·2 ± 3·45	23·9 ± 3·78	59·4 ± 3·31	$v1$ and $v5 > v2, v3, v4$ $v2 = v3 = v4$ $v5 > v1$
Mean percentage contribution to total dry weight by assimilation in the ear	20·3 ± 1·57	7·5 ± 1·99	12·3 ± 1·77	12·3 ± 1·95	20·4 ± 1·19	$v1$ and $v5 > v2, v3, v4$ $v2 = v3 = v4$
Mean percentage contribution to total dry weight by green leaf	16·9 ± 1·14	24·7 ± 2·33	18·1 ± 1·65	20·9 ± 2·00	18·7 ± 2·16	$v2 > v1, v3 = v4, v5$
Mean percentage reduction in grain number per spikelet due to shading of ear	19·5 ± 1·36	10·6 ± 3·65	15·4 ± 2·02	12·4 ± 3·51	37·3 ± 2·44	$v5 > v1, v2, v3, v4.$ $v1 > v2$ $v1 = v3 = v4$
Mean percentage reduction in grain number per spikelet due to defoliation	9·1 ± 1·64	14·1 ± 2·88	9·4 ± 1·00	10·0 ± 2·42	18·7 ± 3·08	$v5 > v1, v3, v4$ $v5 = v2$ $v1 = v2 = v3 = v4$
Mean percentage reduction in 1,000 grain-weight due to shading of ear	19·1 ± 2·53	6·9 ± 2·12	3·9 ± 1·29	12·4 ± 1·00	42·9 ± 5·0	$v1$ and $v5 > v2, v3, v4$ $v5 > v1$ $v4 > v2, v3$
Mean percentage reduction in 1,000 grain-weight due to defoliation	11·4 ± 1·94	13·9 ± 1·95	10·4 ± 1·66	14·4 ± 1·42	7·7 ± 2·07	$v1 = v2 = v3 = v4.$ $v2$ and $v4 > v5$ $v1 = v3 = v5$

* *N.P.* stands for New Pusa, formerly designated Pusa and Imperial Pusa, *P* and *I.P.*, respectively.

green parts diminishes appreciably with time, and the assimilation by the latter might be expected to contribute substantially to ultimate dry matter output. In fact, Boonstra[7], Smith[8], Watson and Norman[2] and Archbold[9] found that, in cereals, assimilation by the stems and by the ears themselves contribute substantially to grain yield.

In the course of work on the physiological analysis of factors determining yield, we have investigated possible varietal differences in respect of the contribution made by assimilation in the ear to grain-yield in wheat. The technique adopted was more or less similar to that of Watson and Norman[2]. The experiment comprised four treatments, namely, control, defoliation (removal of green leaf blades after anthesis), shading the ear and a combination of the last two. All four treatments were included in each pot, there being two shoots per treatment. There were ten replications of each treatment. The calculations were made on the lines adopted by Watson and Norman[2]. From the data presented in the accompanying table, it is concluded that: (*a*) assimilation in the ear contributes considerably more to grain-yield and total plant-weight in *N.P.* 735 and *N.P.* 710 than in the other three varieties; (*b*) the leaf and the ear contribute to total dry weight to the same extent in *N.P.* 710 and *N.P.* 735, whereas in the case of the other three varieties the leaf contributes more to the total dry weight; (*c*) in *N.P.* 165 the contribution of the leaf to total dry weight was, on the whole, the largest; (*d*) as a result of shading the ear, the reduction in 1,000 grain-weight correlated, on the whole, better than reduction in grain-number per spikelet with the differences in assimilation in the ear, which indicates that processes connected with seed setting (fertilization, embryo development, etc.) are not specifically affected; in fact, defoliation also affected seed setting.

It was observed in an investigation on the comparative performances of several varieties of wheat that *N.P.* 710 yielded better than the other three early varieties, *N.P.* 165, Punjab 9*D* and Agra Local, under restricted soil moisture. It is a matter of general observation that *N.P.* 710 and *N.P.* 735 are fairly resistant to black rust, whereas Agra Local and Punjab 9*D* are susceptible, and *N.P.* 165 is only moderately resistant.

It would appear that a variety with ears of high assimilatory capacity would perform relatively better in an adverse environment.

Further investigations are being carried out. Our thanks are due to Dr. B. P. Pal, head of the Division of Botany, for suggesting the choice of varieties and for encouragement.

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Oxygen Uptake of *Asterias* Embryos Before Hatching

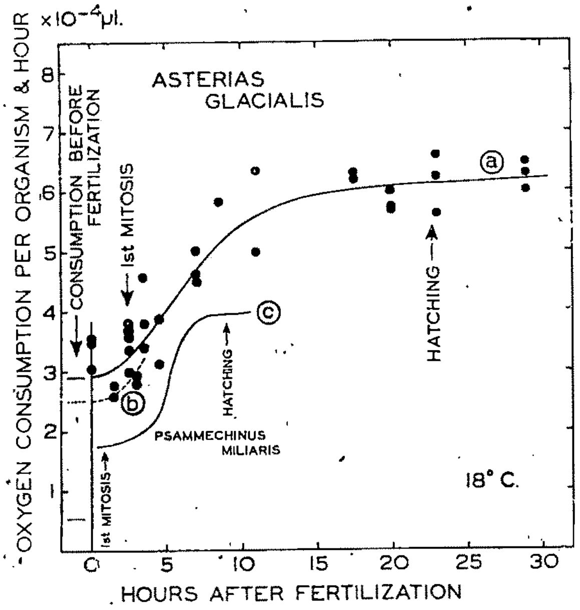
SEA-URCHINS and starfishes differ principally in the oxygen uptake of oocytes and unfertilized eggs[1]; in sea-urchins the respiration of oocytes is higher than that of the eggs, whereas in starfishes the primary oocytes have a much lower oxygen consumption than have the secondary ones or the eggs. In addition, the great increase in oxygen consumption upon fertilization in the sea-urchin egg does not occur in the starfish egg[1-5]. These facts strongly suggest differences in the mechanism of oxidative substrate utilization between the unfertilized eggs of the two groups.

The oxygen consumption of the newly fertilized starfish egg is, however, if measured on a cell-volume basis, remarkably low in comparison with that of the newly fertilized egg of the sea-urchin[1] and of several other marine invertebrates[6]. Thus it might seem that the oxidative mechanism of the young starfish embryo differs from that of the sea-urchin. Probably such a difference would manifest itself in fundamental divergences from the oxygen consumption pattern of the young sea-urchin embryo. Using Cartesian diver micro-respiration technique, the oxygen consumption of this latter has lately[1] been investigated for the time between fertilization and hatching (see also refs. 7, 8).

It has also recently been shown[1] that the exponential increase in oxygen uptake, characteristic of the first few hours of development in the sea-urchin egg[8,1], is roughly applicable to the same time interval in the starfish egg. During this time the starfish egg only passes the first mitosis, whereas the sea-urchin egg reaches the 8- or 16-cell stage. In the present investigation the starfish embryo respiration has been followed for some six hours after hatching.

As previously, Cartesian diver micro-respiration technique at 18° C. was used. In 0·8 µl. of sea-water (32 pro mille salinity) were placed ten eggs or embryos of *Asterias glacialis*, giving pressure differences of approximately 1 cm. per hour. Before fertilization the oocytes were given time to change into unfertilized eggs, that is, time to give off the polar bodies. In *Psammechinus miliaris*, where development to hatching is completed at 18° C. in nine hours, the embryos may, without developmental disturbances, remain inside the diver during the whole of this period. In *Asterias glacialis*, hatching at 18° C. is not completed until 23 hours after fertilization[1]. Moreover, eggs and embryos begin to show signs of dark cytolysis if kept inside the diver for more than five or six hours and simultaneously cease to increase their oxygen uptake rate. Thus divers have to be charged for short-time experiments (not exceeding four to five hours) with material of the different developmental stages, derived from spare cultures maintained at 18° C.

The results are given in the accompanying figure, where each point stands for the mean oxygen uptake of one experiment lasting four to five hours. Uptake before fertilization is denoted, as are the times of hatching and first mitosis (telophase). Curve *a* summarizes the results. In 1947 the uptake values in early development[1] were somewhat lower, as seen from curve *b*. For comparison the corresponding curve for *Psammechinus miliaris* is given in curve *c*.



The method of measurement used necessarily means that biological scattering has greater influence than in the corresponding experiments on *Psammechinus*, where the same embryos could be used throughout[1]. The results obtained, however, undoubtedly show that the increase in oxygen consumption between fertilization and hatching is principally of the same type in both *Asterias* and *Psammechinus*. Thus the results do not indicate that the oxidative mechanism of the young starfish embryo differs from that of the sea-urchin; instead, differences may be anticipated in the oxidative mechanisms of the unfertilized eggs of the two groups.

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Cotton Crop Yield in Relation to the Application of Fertilizers

THE authors of a letter under this title which appeared in *Nature* of March 5, p. 362, seem to be unaware how much is known about the manuring of Egypt's chief crop, and about the soil in which it grows.

The Chemical Section of the Ministry of Agriculture is close to the Faculty of Agriculture from which the authors write, and has published a notable and exhaustive series of official bulletins. Most of these are based upon ten-year runs of field experiments at twenty to thirty different sites each year. A list of those available on my shelves is appended.

This work is almost unknown to agricultural scientists elsewhere (having been published locally) and apparently in Egypt also. My present purpose is to direct attention to these comprehensive contributions to soil science which my former colleagues have made.

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LEAD ISOTOPES AND THE AGE OF THE EARTH

By Prof. ARTHUR HOLMES, F.R.S.

In his recent discussion of this subject, Prof. Harold Jeffreys[1] suggests two statistical methods for estimating t_0, the age of the earth's crust, from the data on the isotopic constitution of ore-leads of different ages, t_m, provided by Nier and his co-workers[2]. The first of these methods is wrong in principle and yields results which are internally inconsistent and widely at variance both with my own solutions[3,4] and with known geochemical data. The second is sound in principle and leads to results consistent with mine;* but it is wrongly stated by Jeffreys, and the solitary example given is arithmetically incorrect. Jeffreys concludes "that no reliance can be placed on estimates of t_0 that depend on the abundance of Pb^{207}". Since my own estimate depends on the abundances of Pb^{206} and Pb^{207} and I can find no reason for modifying it, it becomes necessary to point out how the alleged discrepancies have arisen.

The atomic abundances of the lead isotopes determined by Nier being nearly what they would be if the primeval lead of the earth's crust had been slowly modified by radiogenic additions[3], it is assumed: (*a*) that a sample of lead separated from an ore of age t_m represents a sample of the rock-lead dispersed at the time of ore formation through the part of the crust from which rock-lead was extracted and concentrated into ore; (*b*) that the isotopic constitution of the primeval lead was constant at the time t_0, when the sialic material of the crust first separated from the body of the earth; the initial atomic abundances of $Pb^{204, 206, 207, 208}$ being 1, x_0, y_0, z_0* respectively; and (*c*) that the corresponding atomic abundances, 1, x_m, y_m, z_m, of the isotopes in a sample of ore-lead of age t_m are given by

$$x_m = x_0 + u\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m}) \qquad (1)$$

$$y_m = y_0 + v\,(e^{\lambda_2 t_0} - e^{\lambda_2 t_m}) \qquad (2)$$

$$z_m = z_0 + w\,(e^{\lambda_3 t_0} - e^{\lambda_3 t_m}), \qquad (3)$$

where u, v and w are the present atomic abundances (relative to $Pb^{204} = 1$) of U^{238}, U^{235} and Th^{232} in the rock material from which the rock-lead was extracted to form ore-lead; and λ_1, λ_2 and λ_3 are the respective disintegration constants.

From (1) and (2), we have

$$\frac{x_m - x_0}{y_m - y_0} = \frac{139\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m})}{(e^{\lambda_2 t_0} - e^{\lambda_2 t_m})} = \frac{1}{r}. \qquad (4)$$

Using the relevant data of Table 1 in sets of four, I obtained the following modal solution[4,6]:

x_0	y_0	t_0
10·945	13·51	3,350 m.y. (± about 8–10 per cent).

Shortly afterwards, Houtermans[7] independently published an approximate solution based on the same assumptions, but with somewhat different values for t_m. Since the content of uranium in rocks is generally variable from one region to another, x_m and y_m are also variable in ores of the same age from different regions. If all the assumptions were strictly correct, a plot of x_m against y_m for ores of a given age t_m should be linear, the resulting straight line being what Houtermans calls the 'isochron' for t_m. Two such isochrons for, say, Tertiary–Carboniferous and Pre-Cambrian ores, intersect at a point of which the co-ordinates are x_0 and y_0. Having graphically estimated x_0 and y_0 in this way, Houtermans then calculates t_0 from equation (4). His results are:

x_0	y_0	t_0
11·52 ± 0·60	14·03 ± 0·20	2,900 ± 300 m.y.

No great accuracy is attainable by this method, but the general agreement is of interest.

In the accompanying diagram, x_m and y_m are plotted and the isochrons (corresponding to my solution) are drawn from the point x_0, y_0, which is common to all. The tangent of the angle made by each isochron with the x-axis is r of equation (4), when both variables are plotted to the same scale, and is therefore $5r$ in the present diagram. It will be seen that many of the points fall near the isochrons on which, ideally, they should lie. Few of them, however, fit exactly, and some, especially those of the Joplin leads 9, 10 and 11, and the Austrian lead, 12, are very widely scattered. The existence of such serious departures from the linear relationship demonstrates that in some cases assumption (*c*) does not hold even approximately. This is, of course, only to be expected from a geological point of view. The assumption implies ideal conditions that are unlikely ever to have been realized in the history of any part of the crust. Every region from which lead ores have come must have passed through at least one orogenic cycle, and each time the rock material concerned passed from one cycle to the next—by way of such processes as denudation, sedimentation, metamorphism and granitization—there would be changes in the uranium–lead and thorium–lead ratios. The rather scanty geochemical data available

Table 1

Sample No.	Observed atomic abundances (Nier[2])			Age of ore t_m (m.y.)	Calculated atomic abundances (see text)		
	x_m	y_m	z_m		u	$v \times 10^2$	u/v
1	18·85	15·66	38·63	25	11·97	8·63	139
2	18·67	15·45	38·15	25	11·70	7·78	150
3	18·40	15·53	38·1	25	11·25	8·10	139
4	19·22	16·17	39·15	?			
5	18·07	15·40	38·0	25	10·79	7·58	142
6	18·71	15·70	38·5	25	11·76	8·79	134
7	19·30	15·73	39·5	60	12·76	8·92	143
8	16·04	15·11	35·26	?			
9	21·65	15·88	40·8	100	16·44	9·54	172
10	21·65	15·74	40·36	100	16·44	8·97	183
11	22·38	16·15	41·63	100	17·56	10·62	165
9, 10, 11	*21·89*	*15·92*	*40·93*	*100*	*16·81*	*9·71*	*173*
12	17·75	16·21	38·05	175	10·70	10·90	98
13	18·10	15·57	37·85	220	11·36	8·34	136
14	18·20	15·46	37·7	220	11·52	7·89	146
15	17·36	15·46	37·38	220	10·18	7·89	129
16	18·46	15·66	38·6	220	11·93	8·70	137
17	17·95	15·57	37·9	220	11·12	8·34	133
18	18·43	15·61	38·2	220	11·88	8·50	140
19	14·65	14·65	34·48	600	6·53	4·72	138
20	17·15	15·45	36·53	800	11·27	8·09	139
21	16·27	15·16	35·60	800	9·96	6·94	144
22	16·07	15·40	35·5	1200	11·07	8·31	133
23	15·93	15·29	35·25	1200	10·77	7·83	138
24	15·83	15·45	35·60	?			
25	15·93	15·30	35·3	1330	11·36	8·02	142
Averages (omitting Nos. 9, 10, 11, 12)					11·07	7·97	139

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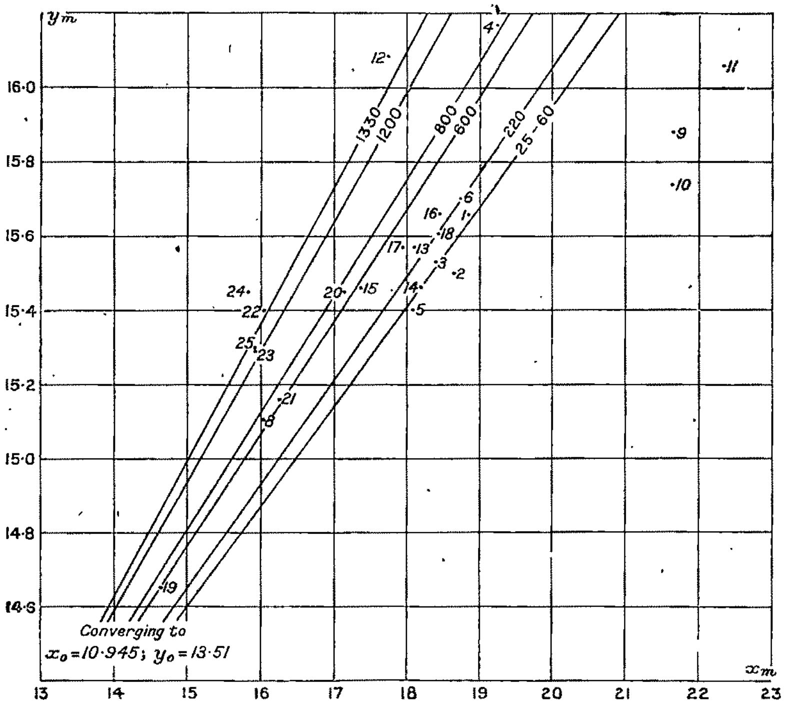
* It should be noticed that Jeffreys[1] calls the original abundances 1, *a*, *b*, *c*, whereas I used these symbols for the abundances in ore-leads[3,4]. The symbols now adopted should avoid any possible confusion.



The plotted points are numbered as in Table 1. $x_m = Pb^{206}/Pb^{204}$; $y_m = Pb^{207}/Pb^{204}$. The diagonal lines are the isochrons for various values of t_m (in m.y.) with t_0 taken as 3,350 m.y.

suggests that generally such changes would be quite small and that decreases would be just as likely as increases. For uranium and thorium some of the evidence is collected in Table 2. The general effect of an increase of uranium relative to lead would be to increase Pb^{206} relative to Pb^{207} in the lead eventually evolved, and so to carry a point x_m, y_m to the right of the isochron; with relative decrease of uranium the point would fall to the left. Some slight scatter of the points, not only along the isochron but also on each side of it, is therefore to be expected, and that is, in fact, what we usually find. Locally, however, there might be very considerable changes, and the apparently erratic Joplin (9, 10, 11) and Austrian (12) leads probably illustrate the cumulative effects of one or more such changes. The isotopic constitution of the Joplin lead could have been reached in a great variety of ways, of which the following is an example: modification of x_0 and y_0 in a source-rock with $(u + v) = 10$ until 2,000 m.y. ago, followed by further modification in the transformed source-rock of a later cycle with $(u + v) = 23$ until the time of ore formation. The Austrian lead requires a change of the opposite kind; for example, a source with $(u + v) = 22$ up to, say, 2,500 m.y. ago followed by a transformed source with $(u + v) = 5·5$. Alternatively, the Austrian lead may be a re-precipitation in Triassic times of an old lead ore of age 1,400 m.y. derived from a source with $(u + v)$ about 16·5.

Explanations of the above kinds are offered to account for what Jeffreys[1] refers to as "a disturbance affecting the values for Pb^{207} by $\pm$ 0·2 or so and not associated with the variation of Pb^{206}", and also in justification of my having excluded the Joplin and Austrian leads from my treatment of the problem. These samples, as the isochron diagram shows, do not even approximately conform to the requirements of assumption (c), and consequently no method of estimating t_0 in which they are considered can be expected to yield reliable or consistent results. It should be added that, pending further information, samples 4 and 8 must also be excluded because their age is uncertain. I originally followed the National Research Council Committee[8] in regarding them as Tertiary; but I find that the ore deposits from which they came occur in Pre-Cambrian rocks and may themselves be of Pre-Cambrian age. It seems likely that the 'abnormality' of their x_m/y_m values would largely disappear if their true geological age were known. I originally excluded the Franklin, N.J., sample (20) on the ground that its age could not be assessed. It can now be added to the 800 m.y. group of Pre-Cambrian leads, since it comes from an orogenic belt for which there are two age determinations of 770 and 860 m.y.

Jeffreys divides the samples into four age-groups (*A*, *B*, *C*, *D* of Table 3). No serious statistical discrepancy arises as a result of combining the Joplin lead with the Tertiary leads to form Group *A*, because the three Joplin leads are represented only by their average, and the effect of this is largely balanced by the inclusion in the same group of samples 4 and 8. But in Group *B* the Triassic Austrian lead (12) is combined with the late Carboniferous leads, and it is solely for this reason that Jeffreys finds a negative correlation coefficient for x_m and y_m in Group *B*. If the Austrian lead is omitted, as it should be (see Group *E*), the correlation coefficient for the Carboniferous leads is + 0·69.

Table 2. Uranium and thorium contents of granitic rocks (Senftle and Keevil[9])

Regions	Geological ages	No. of samples	U in p.p.m.	Th in p.p.m.	$\frac{Th}{U}$
1. All outside North America	Wide range	30	4·35	15·2	3·50
2. Ontario and Quebec	Pre-Cambrian	396	2·90	8·89	3·07
3. North-east coast	Mainly Palæozoic	123	4·98	19·8	3·98
4. Eastern States	Palæozoic and some Pre-Cambrian	143	3·40	11·0	3·24
5. Central States	Palæozoic and some Pre-Cambrian	76	3·52	13·1	3·72
6. South-western States	Wide range	50	4·20	13·3	3·17
7. Western States	Mainly Tertiary	52	3·10	11·1	3·58
8. Rocky Mountain States	Mainly Mesozoic	199	4·98	18·7	3·76
9. Central Canada	Old Pre-Cambrian	126	4·68	11·2	2·39
10. British Columbia and Alaska	Mesozoic – Tertiary	92	3·52	12·2	3·47
		Weighted averages	3·82	12·48	3·27

Table 3

Group	No. of samples	$x_m = \mathrm{Pb}^{206}/\mathrm{Pb}^{204}$		$y_m = \mathrm{Pb}^{207}/\mathrm{Pb}^{204}$		$\frac{s_2}{s_1}$	t_0 (m.y.)	Cor. coeff. x_m, y_m	$z_m = \mathrm{Pb}^{208}/\mathrm{Pb}^{204}$		$\frac{s_3}{s_1}$
		Mean	s_1	Mean	s_2				Mean	s_3	
A : 1–8, (*9, 10, 11*)	9	18·79	1·43	15·63	0·29	0·203	2870	+0·77	38·47	1·43	1·000
B : 12–18	7	18·04	0·36	15·65	0·24	0·663	4700	−0·07	37·95	0·36	1·000
C : 19, 21	2	15·46	0·81	14·90	0·255	0·315	3380	—	35·04	0·56	0·691
D : 22, 23, 25	3	15·98	0·066	15·33	0·050	0·751	4600	—	35·35	0·108	1·636
E : 1, 2, 3, 5, 6, 7	6	18·67	0·38	15·58	0·13	0·342	3680	+0·82	38·48	0·508	1·337
F : 13–18	6	18·08	0·37	15·555	0·074	0·200	2770	+0·69	37·94	0·384	1·038
G : 19, 20, 21	3	16·02	1·03	15·09	0·34	0·330	3450	+0·99	35·54	0·838	0·814

The first method developed by Jeffreys is based on the application of the data for Groups *A–D* (here recalculated in Table 3) to equations (1)–(3). s_1, s_2 and s_3 are the respective standard deviations of the means of x_m, y_m and z_m for a given group; and σ_1, σ_2 and σ_3 are those of u, v and w. If the standard error of u is σ_1, that of x_m is $\sigma_1\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m})$ according to Jeffreys. If this were true, then (omitting the standard error of s_1 itself, which does not affect my criticism) we could write:

$$s_1 = \sigma_1\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m}), \qquad (5)$$

and similarly for s_2 and s_3. For each age-group there is such an equation, and Jeffreys solves these equations for σ_1 and t_0, and similarly for σ_2 and t_0, and σ_3 and t_0. The results, as given by Jeffreys, are:

$$\log \sigma_1 = +\,1{\cdot}54 \pm 0{\cdot}26\,; \quad t_0 = 1{,}250 \pm 170 \text{ m.y.}$$
$$\log \sigma_2 = -\,2{\cdot}25 \pm 0{\cdot}33\,; \quad t_0 = 1{,}390 \pm 170 \text{ m.y.}$$
$$\log \sigma_3 = +\,2{\cdot}54 \pm 0{\cdot}26\,; \quad t_0 = 1{,}430 \pm 180 \text{ m.y.}$$

From this it appears that

$$\sigma_1 \text{ is about } 34{\cdot}7\,; \ \sigma_2 \text{ is about } 0{\cdot}0056\,; \ \sigma_3 \text{ is about } 347. \qquad (6)$$

Equation (5), however, would be true only if σ_1 referred to the same group as s_1, whereas in solving the equations it is assumed that σ_1 is the same for all four groups. Actually σ_1 is variable from group to group, just as s_1 is. This can be illustrated from the estimates of u listed in Table 1, calculated from equation (1) with $t_0 = 3{,}350$ m.y. The respective values of σ_1 for groups *A*, *B*, *C* and *D* are found to be 2·21, 0·59, 1·71 and 0·57.

From the data summarized in Table 2 it is possible to estimate at least the order of the real values of σ_1, σ_2 and σ_3 for the variation of uranium and thorium in granitic rocks. To transform parts per million of uranium and thorium into atomic abundances relative to $\mathrm{Pb}^{204} = 1$, the average content of lead (207·2) in granitic rocks may be taken as 21 p.p.m. and the average total abundances as 74. $\mathrm{Pb}^{204} = 1$ thus corresponds to 0·28 p.p.m. of Pb^{204}. Allowing for atomic weights, we find:

$$\left.\begin{array}{l} \mathrm{U} \ = \ 3{\cdot}82 \text{ p.p.m.} \equiv u = 11{\cdot}61 \text{ and } v = 0{\cdot}08 \\ \mathrm{Th} = 12{\cdot}48 \text{ p.p.m.} \equiv w = 39{\cdot}19 \end{array}\right\} \qquad (7)$$

These results for u and v agree closely with those calculated from my solution in Table 1.

The standard deviations of the amounts of uranium and thorium in granites (data of Table 2) are 0·86 and 3·97 in p.p.m., corresponding to:

$$\sigma_1 = 2{\cdot}61\,; \quad \sigma_2 = 0{\cdot}019\,; \quad \sigma_3 = 12{\cdot}68.$$

Variation in the lead content of granites is not likely to increase these estimates, but rather to decrease them, since the elements concerned tend to vary sympathetically in rocks. If, as is probably the case, the ratio of uranium to lead varies less than uranium, and of thorium to lead less than thorium, then the above estimates for σ, etc., would be too high.

It will be seen that the values arrived at by Jeffreys for σ_1 and σ_3 in (6) are not only very much higher than the probable values, but are actually higher than the values of u and w, of which they purport to be the standard deviations. Even allowing for the errors introduced by ignoring the variation of σ_1, etc., from group to group, I find it impossible to understand how the values in (6) can have been extracted from the original data. My own results (cf. 7 and Table 1) are consistent with geochemical data, whereas those of Jeffreys are not. My results (Table 1) give $u/v = 139$, which is the accepted value, but Jeffreys finds $\sigma_1/\sigma_2 = 6{,}160$. Moreover, the results given by Jeffreys for σ_1, etc., and t_0 are internally inconsistent. If the figures in (6) are used to calculate t_0 from equations such as (5), the following results (in m.y.) are obtained:

	$\sigma_1 = 34{\cdot}7$	$\sigma_2 = 0{\cdot}0056$	$\sigma_3 = 347$
Group *A*	320	4,150	120
Group *B*	270	3,900	240
Group *C*	770	3,980	750
Group *D*	1,350	2,570	1,270

whereas Jeffreys gives the following figures for t_0:

$$1{,}250 \pm 170 \quad 1{,}390 \pm 170 \quad 1{,}430 \pm 180$$

I can only conclude that this method is not only wrong in its assumption of a constant σ_1, etc., but that a serious slip has probably been made in the working.

The second method suggested by Jeffreys for finding t_0 is essentially the Houtermans[7] isochron method treated statistically, instead of graphically. From equation (4) we can write:

$$s_1/s_2 = 139\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m})/(e^{\lambda_2 t_0} - e^{\lambda_2 t_m}). \qquad (8)$$

Jeffreys, in his equation (7), writes, "$\log s_1 - \log s_2$" for s_1/s_2, but this is evidently a slip. Unfortunately, Jeffreys applies this method to Group *A* only and gives $t_0 = 4{,}000 \pm 370$ m.y. as the solution, whereas the correct value is $t_0 = 2{,}870$ m.y. ± about 10 per cent. In Table 3 I have applied the method to groups *A–D* and also to groups *E*, *F* and *G*, from which the 'abnormal' samples and those of uncertain age have been omitted. It will be seen that the average value of t_0 for *E*, *F* and *G* is 3,300 m.y., which agrees closely with my estimate[4] of 3,350 m.y. If the result from Group *D* were also included, the average t_0 would become higher, but Group *D* is not a satisfactory one for the application of this method, because the lead samples concerned have almost identical isotopic constitutions.

Jeffreys writes, "If we accept the smaller values of t_0, or indeed of any value less than 3,000 m.y., the variation of Pb^{207} as between ores of the same age is greater than we should expect from the variation of Pb^{206}". This statement clearly favours a value of t_0 above 3,000 m.y. But Jeffreys continues, "On the other hand, if we adopt a value near 4,000 m.y., we have no explanation of the small scatter of the values for the three oldest ores" (Group *D*). Surely, however, the small scatter is purely a matter of chance and calls for no other explanation. Only two localities are involved, samples 22 and 23 being from Broken Hill, N.S.W., and sample 25 from Great Bear Lake, Canada, and there would be nothing remarkable in the granitic rocks of two such areas having nearly the same uranium, thorium and lead contents. The objection raised by Jeffreys to an age near 4,000 m.y. would be valid only if Group *D* were represented by samples from many localities and still showed a small scatter. As it is, the objection has no weight. Indeed, Jeffreys himself in his final paragraph says it is quite probable "that the small scatter . . . is an accidental agreement". These reasons against the use of Group *D* in this particular method do not apply to my original treatment, because there the data for the Group *D* samples were combined, not with each other, but with those for the samples belonging to groups *E*, *F* and *G*. The method I devised is admittedly a long and tedious one, but it has the advantage of giving a most probable solution, based on all the relevant data, not only for t_0, but also for x_0 and y_0. Meanwhile, I can at least agree with Jeffreys that many more isotopic analyses of old leads would be necessary to improve the estimate appreciably.

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[4] Holmes, A., *Nature*, **159**. 127 (1947).

[5] Holmes, A., *Geol. Mag.*, **84**, 123 (1947).

[6] Holmes, A., *Endeavour*, **6**, 99 (1947).

[7] Houtermans, F. G., *Z. Naturforsch.*, **2a**, 322 (1947).

[8] Report of the Committee on the Measurement of Geologic Time for 1940–41, N.R.C., Washington, 59 (1941).

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MARINE BIOLOGY AT PLYMOUTH

THE latest issue (vol. 27, No. 3) of the *Journal of the Marine Biological Association of the United Kingdom*, again a large publication, provides articles of interest for many tastes in marine biology. There are two papers on fisheries, five on worms, two on molluscs, one on tunicates and one on seaweeds.

Mr. G. A. Steven, writing on mackerel migrations, continues the work published by Mr. P. G. Corbin in 1947. He states the case for depth spawning in this fish, which explains the apparent anomaly that English Channel mackerel migrate *offshore* to an area west of the Scillies in spring, but North Sea mackerel move *inshore* to the deep waters off Norway. The spawning grounds are in both cases near the 100-fathom contour. After the spring spawning the shoals disperse, appear inshore round the southern coasts of Great Britain in the surface waters, and, as winter approaches, congregate on the sea floor in scattered localized areas where there are banks and gulleys.

Mr. P. G. Corbin contributes the ninth in the series "Seasonal Abundance of Young Fish" for the year 1947, and reports that the total of all species of young fish was the lowest yet recorded, "thus fully bearing out the observations of the incomplete year of 1946 and the deductions from the 1939–46 winter phosphate data".

Mr. D. P. Wilson describes the development of *Ophelia bicornis* after artificial fertilization, the first time that the larval development of any member of the family Opheliidæ has been observed. Of interest is the fact that a secretion from the four anal papillæ and the parapodial lobes enables the metamorphosing larva to adhere to solid objects, such as grains of sand. Mr. Wilson considers that the development of *Ophelia* is a typical one among polychætes; it is simple and unspecialized. In a second paper he describes experiments on the metamorphosing larva which indicate that the larva can spend several weeks searching for a suitable substratum on which to metamorphose. It prefers smooth, rounded grains of quartz, uniform in size, and will die if it cannot find conditions as near as possible to its natural habitat when adult. The stimulus to metamorphose is probably tactile, not chemical.

Miss Jean Hanson illustrates specific differences in the genera *Apomatus* and *Protula* by a study of the pattern of the superficial blood vessels on the ventral surface of the thorax, and as a result puts forward the view that *Apomatus* and *Protula* should be combined in one genus, and similarly *Salmacina* and *Filograna*; but she does not suggest which names should be retained.

A new Enchytræid from the beaches of North Wales is described by Helge O. Backlund of Sweden. It has been named *Lumbricillus reynoldsoni* after its discoverer, Dr. T. B. Reynoldson, of Bangor.

Another little-known life-history, that of *Arenicola marina*, has been ably demonstrated by Dr. G. E. Newell. Working on the Whitstable Flats, he collected worms at weekly intervals throughout the year, and found that spawning occurred between the new and full moon in the second half of October, the maximum being at the first quarter, or neap tide. Eggs and sperms were deposited on the surface of the sand at extreme low-water as thin films and milky puddles respectively. The trochophore is demersal, hatching in four or five days after fertilization. It inhabits the *Fucus* zone, and is therefore carried inshore on the tide. Next spring, after metamorphosis, it moves down the beach, and spawns for the first time when two years old. Many worms die after spawning. Discovery of the egg film and autumn spawning settle two questions that have worried marine zoologists for many years.

Prof. C. M. Yonge continues his studies on the structure and function of the mantle cavity in the Mollusca by an account of a shallow burrowing lamellibranch, *Spisula subtruncata*, and a deep-burrowing one, *Lutraria lutraria*. In the former, which inhabits silty sand, the fourth pallial opening for the removal of waste matter from the pallial cavity, just anterior to the inhalant siphon, is provided by slight divergence mid-ventrally of the otherwise closely apposed mantle folds. Long frontal cilia on the gills and a siphonal valve on the inhalant aperture assist in the cleansing operation. In *Lutraria*, a member of the same family, there is a similar waste canal, but the long frontal cilia and siphonal valve are absent.

Dr. Vera Fretter has investigated some of the minute prosobranchs of rock pools, *Skeneopsis planorbis*, *Omalogyra atomus*, *Rissoella diaphana and R. opalina*. In their adaptation to a rock-pool habitat these four molluscs have become highly specialized. The ctenidium and osphradium are reduced in *Skeneopsis* and absent in the other genera; the gut is simple, and the reproductive organs are complex. *Omalogyra* and *Rissoella* are hermaphrodite. The young, hatched from egg capsules in two weeks, crawl about, become mature in six weeks, and reproduce in the same season. All are herbivorous, but assimilate only the cell contents of the plants they consume. They anchor themselves by a mucous rope paid out from the posterior pedal gland. This is an interesting paper with handsome illustrations.

Prof. N. J. Berrill has studied two colonial ascidians, *Stolonica socialis* and *Distomus variolosus*, and as a result considers that the botryllids and the polystelid section of the Styelidæ "exhibiting palleal budding, comprise a natural group". These also are the only ascidians with a photolith, responsive both to light and gravity, in the tadpole phase. He suggests, therefore, a family Styelidæ, with sub-families Botryllinæ and Styelinæ. But the position of *Polycarpa* and other simple Styelids is still obscure.

A welcome new feature is the first of a promised series on algæ. Dr. Mary Parke, commencing with the family Laminariaceæ, writes on the growth of *Laminaria saccharina* from the Devon and Argyll coasts. Her investigations prove that the minute gametophyte is capable of reproduction throughout the year, although the bathymetric level and habitat control its fertility. Sporophytes develop at low levels in spring, summer and autumn, but at higher levels in winter, early spring, late summer and autumn. They can live three years under suitable conditions, with more rapid growth-periods in the first half of each year. The distal frond tissue is cast continuously. Sporophytes first reach maturity at the end of their first year. Dr. Parke is making a type collection of seaweeds from the Plymouth area.

That the Plymouth Laboratory is flourishing is shown by the impressive list of researches now being carried out, by the names of the distinguished visitors who come to it from all parts of the world, and, perhaps not least, by the 83,000 local visitors attracted to the aquarium. The number of members of the Association, however, shows only a slight increase, and might be augmented, with benefit both to the members and to the Laboratory.

Dr. F. S. Russell's lecture on the Plymouth Laboratory, delivered to the Royal Society in March 1947, has been reprinted in the *Journal*, and provides very interesting reading. Both it and the photographs make every marine biologist long to go down to the sea again.

N. B. EALES

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION[*]

THE detailed report of the Director General of the United Nations Educational, Scientific and Cultural Organisation on the activities of the Organisation in 1948 could with advantage have been provided with an index, as heads under which the information is supplied—reconstruction, communications, education, cultural interchange, human and social relations, natural sciences—overlap and are not those under which information is necessarily sought. The work of the library, for example, is described under both the first two headings, while much that is of direct interest to scientific workers is scattered under other headings than that of natural sciences. For example, the emergency action taken to deal with the needs of war-devastated countries for books, educational material, and scientific and technical equipment, including the Scientific Equipment Scheme, is described under "Reconstruction", which also records the issue of the second volume of the "Book of Needs", covering surveys mainly in South Asia and the Far East and in Malta, with an appendix including new data on needs in European countries. The international fellowship programmes are described under "Communications". Forty-eight fellowships were awarded at Mexico City in November 1947 in the following fields: science and social development; cinema and radio education; educational problems of war-affected children; librarianship; educational administration; and art and music education. Six fellowships, one in each subject, have been allocated to China, Czechoslovakia, Greece, the Netherlands, Norway, Poland, Denmark and the Philippines.

In accordance with the recommendations of a committee of nine experts from Czechoslovakia, France, the Netherlands, Sweden, the United Kingdom and the United States of America, an International Conference on Scientific Abstracting is projected for June 1949, and the International Federation for Documentation is making a survey of scientific abstracting services on behalf of Unesco. Publications exchange has also been considered, and an approach made to the delicate and complex problems of copyright. Besides the preparatory conference of representatives of universities at Utrecht last August, an interim committee has been set up to develop plans for an international association of universities and like institutions, including an International Universities Bureau. Under the museums programme, advice is being given to museums in member States on exhibitions available for international distribution and on those for which there would be an international demand if they were formed. Questions of methods in political science, the popularization of science and the social implications of science are also receiving attention, while the work of the Field Science Co-operation Offices in Rio de Janeiro, Cairo and Nanking is already proving very successful. Further reference is made to the work of the International Institute of the Hylean Amazon, and an International Conference on High Altitude Research Stations at Interlaken held during August 31–September 3 recommended the establishment by the International Council of Scientific Unions of a mixed commission to facilitate the exchange of information, and that existing high-altitude stations should be organised into a network with additional stations to be established. Besides participating in the preparations for the Scientific Conference on the Conservation and Utilization of Resources in 1949, the Organisation is convening a Technical Conference on the Protection of Nature to be held in June 1949 and has organised a European and African Technical Symposium for the preparatory study of certain regional problems.

Elsewhere, in his general survey, Dr. Huxley refers to the experimental scheme for book coupons covering six countries, to the international summer school for librarians, the creation of the Mass Communications Projects Division, to the need for careful thought on the policy of publications and sponsorship of international publishing activities, and to the importance of the population problem for the tasks of the Organisation.

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[*] United Nations Educational, Scientific and Cultural Organisation. Report of the Director General on the Activities of the Organisation in 1948. (Unesco Publication 226.) Pp. 119. (Paris: Unesco, 1948.) 7s. net.

RAPKINE MEMORIAL MEETING

THE president of the Royal Society, Sir Robert Robinson, presided at a meeting held at the Society for Visiting Scientists on March 9, in memory of the late Louis Rapkine. The chief guests were the French Ambassador and Madame Sarah Rapkine. Mlle. A. Deloyers and Prof. Francis Perrin represented the Commissariat à l'Energie Atomique, and Dr. Magat the Centre National de la Recherche Scientifique; Dr. A. M. Lwoff of the Pasteur Institute, Prof. S. Mandelbrojt of the Collège de France, Prof. J. Hadamard and Dr. A. Mirlès also attended from France.

Sir Robert Robinson said that they had gathered together to give tribute to the memory of a great man whose work was not complete at the time that he died, and whose loss was therefore regretted the more poignantly. He welcomed the French Ambassador and Mme. Rapkine, and their French colleagues.

M. Massigli, speaking in French, said that he came to know Rapkine after he had joined the de Gaulle movement in London, and in his efforts to secure the escape of scientific men from France Rapkine accomplished a great work in fostering Anglo-French scientific relations.

Dr. Joseph Needham spoke of the earlier part of Rapkine's scientific life. He met him first in 1925 at the Marine Laboratory at Roscoff. Dr. Needham said that he and his wife, Dr. Dorothy Needham, were both profoundly influenced by their conversations with Rapkine. He had helped to emancipate them from the insularity of English cultural and social life. Dr. Needham remarked that France was the only country where a young man with Rapkine's unorthodox background could have secured a training in scientific research. His adoption of French nationality was a tribute to French civilization. Rapkine had an extraordinary quality of making people act and live up to the best that was in them. His piercing look made one feel as if one's own conscience was speaking to one, and yet he had such charm that no one ever took offence. His hero was Spinoza, who died at almost exactly the same age of forty-four.

Dr. Lwoff gave an account of the latter part of Rapkine's scientific researches. His early work had led him to the study of the chemical processes of cell division. Gowland Hopkins and Dixon had established that the reduction of oxidized glutathione by tissues occurs only in the presence of soluble sulphydryl groups. Rapkine postulated that cell division is preceded by protein denaturation, which is responsible for the free sulphydryl groups found in the egg. He confirmed these deductions by experiment, and found considerable increases in lactic acid production. He tried to inhibit reversibly the division of the egg. Dickens and Rapkine independently proved that the reaction between glutathione and mono-iodoacetic acid is stoichiometric. The inhibition of cell division by mono-iodoacetic acid was demonstrated in 1937. In the following year Gowland Hopkins discovered that the activity of succino-dehydrogenase is correlated with the presence of sulphydryl groups in the molecule. Independently, Rapkine prepared triosephosphate dehydrogenase and proved that the enzyme is inactivated by oxidized glutathione.

Out of this work came the crowning scientific discovery of his career, namely, the proof, together with Mme. Rapkine and Trpinac, of the protection by cozymase of the sulphydryl groups of dehydrases. In 1939, Gowland Hopkins, the master of British biochemistry, wrote: "His researches have thrown much light on the fundamental phenomena of cell division. They have shown the biological importance of sulphydryl groups. And, directly or indirectly, they have illuminated many other aspects of cell activity. His work is of fundamental importance."

In 1939 Rapkine resisted the temptation to follow up his brilliant researches, and accomplished his destiny by giving to his elected country, during the most tragic period of its history, seven years of a life which was to be so brief.

Prof. Francis Perrin recounted Rapkine's part in rescuing French scientific men after 1940, among whom were himself, and his father the late Jean Perrin, and of how he collected funds in America and found posts for them. He had only recently adopted French nationality, but his loyalty, foresight and moral conduct were an example to his new countrymen. He became the undisputed leader of the French scientific workers in exile, and was not only their chief but also their conscience. None of them would make any decision without his moral approbation.

Rapkine's work for refugees was described by Prof. A. V. Hill. Shortly after the formation of the Academic Assistance Council in Britain in 1933, a similar committee was formed in France. It met with the usual difficulties, and gradually ceased to function. In 1936, a new committee was formed on the initiative of Rapkine. Rapkine had the same difficulties as the earlier committee, and the legacy of its failure, but he overcame them. If he believed in a cause, no obstacle was unsurmountable for him. He had a horror of bureaucracy and a belief in vigorous direct action, qualities which were later to mean life and freedom for a large number of French scientific men and their families. Rapkine started the formation of the international Society for the Protection of Science and Learning, under the presidency of Niels Bohr. His faith, his endless compassion, his integrity and his extraordinary practical sense were an inspiration to all.

Prof. Hadamard referred to Rapkine's sacrifice of years of his scientific life, and the loss of his scientific future. Rapkine had told him after the War that he had devoted years of his life to the rescue of scientific men, and he now would return to science, and acquire—which he thought he could—a great and important scientific authority, and which he would then use for the assistance of great public causes.

Prof. Mandelbrojt described Rapkine's leadership of the French Scientific Mission. He had saved many French scientific workers from concentration camp and death, and had found work for them in America. But none were deeply satisfied. Their souls were not in America but with their colleagues in occupied France. They felt that others were fighting the war for them, and they had a deep desire to join in the fighting for liberation. Many tried to enlist in the army, but were too old or otherwise unsuitable. In 1943 Rapkine visited England and realized the importance for France of a knowledge of the new scientific methods developed during the War, especially of operational research and team-work. He returned to America, and mobilized his group to go to England to assist the British effort in these fields. It was a measure of Rapkine's character that the British authorities were willing to entrust such important new knowledge to him and anyone recommended by him; and so the French Scientific

Mission was able to bring to France at the earliest possible moment much new information on operational research, radar, aeronautics, nutrition and medical research, etc.

Prof. Mandelbrojt ended his address with a proposal for the foundation of an International Rapkine Memorial Fund consecrated to the solution of those problems in which Rapkine had been interested, and to which he had devoted his genius.

Dr. Magat described how in February 1941, when he left as a refugee for America, his state of mind was low, and the future uncertain. When he arrived, the first person he saw was Rapkine, and wherever anyone arrived Rapkine was there to meet them. "It is important," he said, "for them to feel that they are not alone here."

Prof. J. D. Bernal read an appreciation by Prof. P. M. S. Blackett, who had written that Rapkine, in setting up his Mission, had from the very beginning seen more clearly than others the real facts of the situation. He realized what could be achieved, and what not, and he laid his plans accordingly. But vision and intelligence alone would not have led him to the success he attained; what made this success possible were his gifts of character—such a combination of intelligence, persistence and charm, with first-class scientific ability, as are rarely found in one man.

Prof. Bernal added on his own behalf that Rapkine's personality and achievement had been taken too much for granted. We accepted him as part of the atmosphere and of the century. But, in fact, Rapkine was the pattern of the man on which the scientific world of the future will be based.

Mr. J. G. Crowther described how Rapkine joined at an early stage in the founding of the Society for Visiting Scientists. He was a foundation member of the Executive Committee, and the first assistant secretary. In the latter capacity, he was asked to search for a house, with the suggestion that one might be found in Old Burlington Street. Within twenty minutes he returned with news that the present premises of the Society were available and suitable. Mr. Crowther said that Rapkine was sometimes known among his friends as the 'Prophet'. That, indeed, was what he was: leading his people out of persecution, and by his character and example revealing to them the moral law.

Sir Robert Robinson, in concluding the proceedings, described the premature loss of Rapkine as irreparable, and one to be compared with that of Moseley in the First World War. He hoped in particular that Prof. Mandelbrojt's proposal of an International Rapkine Memorial Fund would be instituted.

SOLDERING

MR. W. R. LEWIS, development officer of the Tin Research Institute, recently gave the Institution of Electronics a review of the problem of soldering, particularly those aspects which have led to the continuous-belt technique of soldering articles together, or for making tin-plate boxes, when the mode of heating is with high-frequency currents generated by thermionic-valve plant. The union of metallic surfaces is greatly facilitated by previous 'tinning', that is to say, coating the juxtaposed surfaces with pure tin or a solder, either electrolytically or by hot-dipping; 'tinned' surfaces can be brought very close together and the space between, even if only a few thousandths of an inch, filled with solder, ingress being by capillary action. Thus the making of tin-plate boxes, in which the edges of the pieces are hooked or bumped together, entirely depends on this capillary action, using rings of solder wire, cored with the requisite flux.

The action of the flux is to remove the oxide film. Recent advances include many organic materials which, under the moderate temperatures prevalent in soldering, decompose and release acid, particularly hydrochloric acid, for cleaning the surface. Among these substances are oleic acid, abietic acid (already in resin or rosin), as well as the more frequently used ammonium and zinc chlorides. In the 'activated' fluxes the aim is to produce at the union just sufficient acid to remove the film, so that no appreciable acid is left to give rise to corrosion in damp atmospheres. The choice of flux depends on the metals to be joined, and some fluxes are better than others; for example, phosphoric acid for steel, copper and brass, and lactic acid for iron and brass. The problem with aluminium is to get the tin or solder into intimate contact with the base metal without the oxide film intervening, and this is frequently achieved by vigorous scratching. An alternative suggestion is to build up the oxide film by treatment with phosphoric acid and nitric acid so that it breaks away more easily; the flux then protects the base metal surface while it is being 'tinned' with a high-tin solder.

The art of soldering has been greatly enhanced by the standardized methods of testing solderability, such as the spreading test, the Schumacher–Bouton–Phipps twisted-wire test for capillarity, the Earle test developed in Great Britain during the War for recording the surface pulls across the solder on a kollagraph, and the war-time *D.T.D.* 599 specification. A word of warning must be noted, with respect to the difficulty of controlling the thickness of fine electro-plated films of 'tinning' when large batches of small articles are placed in the electrolytic bath; a considerable factor of safety should be used to ensure a universal minimum.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 21

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. W. Ellison: "Reclamation and Use of Marginal Land".

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. A. O. Rankine, F.R.S.: "Experimental Studies in Thermal Convection" (Guthrie Lecture).

RATIONALIST PRESS ASSOCIATION (at the Alliance Hall, Palace Street, London, S.W.1), at 7 p.m.—Dr. J. C. Flugel: "Psychology and the Problems of Peace". (Further Lectures on March 28 and April 4.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Eric Shipton: "Travels in Sinkiang".

Tuesday, March 22

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. W. E. H. Stanner: "Sociological Problems of the Groundnut Scheme in Tanganyika".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. C. Trevor: "Some Problems of Race".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Magnetic Amplifiers" (to be opened by Mr. F. H. Belsey).

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. L. Dudley Stamp: "Alaska".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. G. H. Tupling: "The Early Metal Trades and the Beginnings of Mechanical Engineering in Lancashire" (Fourth Annual University Lecture).

Wednesday, March 23

Physical Society, Low Temperature Group (at Petrocarbon, Ltd., Eccles, Manchester), at 9.45 a.m.—Science Meeting.

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Society of Chemical Industry, Nutrition Panel of the Food Group (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Prof. J. Beattie: "The Effect of Non-Protein Calories on the Utilization of Proteins".

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. S. Rodda: "Photo-Multipliers".

Thursday, March 24

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Physics and Chemistry of Hydrocarbon Gels" (to be opened by Prof. E. K. Rideal, F.R.S.).

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Animal and Plant Populations in Fresh Water" (to be opened by Dr. T. T. Macan and Mr. D. Le Cren).

Institute of Sociology (at the Royal Institute of British Architects, Portland Place, London, W.1), at 5.30 p.m.—Prof. T. H. Pear: "The Relations between Anthropology, Psychology and Sociology".

Chemical Society, Manchester Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Prof. M. Stacey: "The Chemistry of the Deoxy-Sugars".

Royal Institute of Chemistry, London and S.E. Counties Section (in the Material Research Laboratory, Philips Electrical, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Dr. J. S. Anderson: "The Chemistry of Semi-conducting Solids".

Friday, March 25

Biochemical Society (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 11 a.m.—Annual General Meeting: Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Manchester Statistical Society, Statistical Methods Study Group (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 5.30 p.m.—Mr. A. S. Wharton: "The Organisation of a Market Research Department".

Manchester Statistical Society, Industrial Group (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. N. T. Gridgeman: "Applications of Statistical Methods in Biology".

Sheffield Metallurgical Association, Modern Methods of Analysis Group (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. H. Oldfield: "Solution Analysis by Emission Spectroscopy".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. F. A. Paneth, F.R.S.: "Whence Comes Meteorites? Views Ancient and Modern".

Saturday, March 26

Amateur Entomologists' Society (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1), at 2 p.m.—Exhibition of Entomological Specimens and Technique, and Lectures.*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer or Assistant Lecturer with qualifications in Pure Mathematics, a Lecturer or Assistant Lecturer with qualifications in Applied Mathematics, and a Research Assistant in Mathematical Statistics—The Registrar, The University, Manchester 13 (March 25).

Senior Assistant in Physics—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford (March 26).

Laboratory Technician (male)—The Secretary, Institute of Ophthalmology, Judd Street, London, W.C.1 (March 26).

Assistant Physicist in the Department of Physics applied to Medicine—The Secretary, Middlesex Hospital Medical School, London, W.1 (March 26).

Biochemist to participate in biochemical studies of lactation involving the use of tracer isotopes, and a Biochemist or Chemist to assist in researches in biochemistry of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (March 26).

Lecturer in Inorganic Chemistry and Metallurgy, a Lecturer in Biology, and a Lecturer in Physics—The Principal, Acton Technical College, High Street, Acton, London, W.3 (March 26).

Assistant in the Science Group of Departments, London Headquarters (to establish and maintain contacts with all branches of the sciences and generally to promote the scientific activities of the Council overseas)—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (March 28).

Travelling Scholarship in Sanitary Science or Municipal Engineering and Hygiene—The Clerk, Chadwick Trustees, 204 Abbey House, Westminster, London, S.W.1 (March 31).

Specialist Advisory Officers in soil chemistry, the chemistry of animal nutrition, entomology, plant pathology and bacteriology, Assistants for field and laboratory work, and Chemists for analytical work on soils, feeding-stuffs and other agricultural materials—The Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N.W.1, endorsed 'N.A.A.S.' (March 31; overseas, May 14).

Research Fellowship, and a Research Assistant, in the Department of Economics, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 31).

Research Assistant (to work under the direction of the research officer in bee-keeping) on field and laboratory problems relating to honeybees and their management—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (March 31).

Senior Scientific Officer or Scientific Officer as Chemist at the Marine Laboratory, Aberdeen, a Senior Scientific Officer as Chemist at the Brown Trout Research Laboratory, Pitlochry, and a Scientific Officer as Botanist at the Brown Trout Research Laboratory, Pitlochry—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (March 31).

Senior Lecturer in Agriculture, a Lecturer in Poultry Husbandry, a Lecturer in Farm Machinery and Implements, and a Lecturer in Agricultural Science, at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (April 2).

Principal Scientific Officers or Senior Scientific Officers (unestablished) for veterinary research posts at a Ministry of Supply Research and Development Establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (April 2).

Lecturer or Assistant Lecturer in Botany with special qualifications in Taxonomy, and an Assistant Lecturer in Economic Botany with qualifications in Agriculture or Horticulture—The Registrar, The University, Manchester 13 (April 8).

Derby Chair of Zoology, and a Director of the Marine Biological Station, Port Erin—The Registrar, The University, Liverpool (April 9).

Physicist at the Geophysical Observatory, Wellington—The Official Secretary, Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 15).

Lecturer in Child Psychology—The Registrar, The University, Manchester 13 (April 15).

Demonstrator in the Department of Chemistry—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 19).

Lecturer in Geology—The Registrar, University College, Hull (April 19).

Lecturers (2) in Mathematics—The Secretary, The University, Aberdeen (April 20).

International Wool Secretariat Scholarships—The Registrar, The University, Manchester 13 (April 30).

Lecturer or Assistant Lecturer in Zoology in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 1).

Director—The Chairman, Coconut Research Scheme, Lunuwila, Ceylon (May 11).

Lecturer in the Mathematics Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Technician (Grade B) with histological experience in the Department of Surgery—The Secretary, Marischal College, Aberdeen.

Qualified Technician or Student Technician in the Biochemistry Department—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Medical Laboratory Technicians (2, one in the Bio-chemical Department and one for the Hæmatology and Clinical Pathology Department)—The Secretary, County Hospital, Lincoln.

Senior Technician—The Regional Transfusion Officer, Southmead, Bristol.

Mathematician (with a first-class honours degree and, preferably, some knowledge of the theory of elasticity) for research in applied mechanics—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Research Assistant (preferably with honours degree in zoology) for research laboratory—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

Studentships in Plant Breeding or Entomology—The Secretary, Empire Cotton Growing Corporation, 1a Harrington Road, London, S.W.7.

Lecturer in Physics and Mathematics at the Municipal Technical College—The Director of Education, Education Office, St. Helens.

Technician at the High Tension Laboratory, Lahore, Pakistan—The Education Authority, High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1.

Lecturer in Chemistry—The Principal, Derby Technical College, Normanton Road, Derby.

Senior Lecturer in Chemistry—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Management Abstracts. Vol. 1, No. 1, September 1948. Pp. 36. (London: British Institute of Management, 1948.) 3*s.*; annual subscription, 30*s.* [209

Agricultural Research Institute of Northern Ireland. Twenty-first Annual Report, 1947–48. Pp. 39. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1948.) [209

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 9: Computation of Traffic Stresses in a Simple Road Structure. By Dr. L. Fox. Pp. iv+28. (London: H.M. Stationery Office, 1948.) 9*d.* net. [229

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 12: Properties of Road Tars and Asphaltic Bitumens in relation to Road Construction. By Dr. A. R. Lee. Pp. iv+23. (London: H.M. Stationery Office, 1948.) 9*d.* net. [299

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PRESERVATION OF THE COUNTRYSIDE

THE National Parks and Access to the Countryside Bill introduced in the House of Commons on March 17 has been long awaited—indeed so long that many despaired of seeing anything done. The appointment of a National Parks Commission, with wide duties, will mark an important step forward.

The announcement by the Lord President of the Council on February 11 of the establishment of the Nature Conservancy followed hard on an adjournment debate in the House of Commons in which the attitude of the Minister of Town and Country Planning had indicated the Government attitude towards Nature conservancy, national parks and the preservation of flora, fauna or scenic beauty. This debate, on quarrying in the Peak district of Derbyshire, on February 7, was admittedly held at an hour when the House of Commons is not normally well attended. Even so, the presence of only half a dozen members was as discouraging to those who are anxious for the effective preservation of Britain's dwindling resources of scenic beauty, flora and fauna as was the reply given by the Minister of Town and Country Planning. Mr. Silkin's inclusion as member of the reconstituted Committee of the Privy Council for Agricultural Research and Nature Conservation may possibly educate him as to the wider issues, but his conversion may have little effect if the House continues to be apathetic to the preservation of amenities or scenic, cultural or scientific values, and is interested only in the economic exploitation of physical resources to the exclusion of considerations of recreation, health and beauty. The New Forest Bill at present before the House of Lords makes no provision for preventing damage to areas of scientific importance. That Bill also contains two clauses which permit the enclosure of a further 5,000 acres for timber-growing and 3,000 acres for agriculture. Strong objection has been made to both clauses as detrimental both to commoners' rights and to public amenity, and it has also been urged that the Bill permits road construction with insufficient regard to amenity.

The occasion of the debate on February 7 was the approval by the Minister of the great extension of the existing cement works in the Hope Valley, an approval which was challenged in forthright terms by Mr. H. Molson, member for the High Peak division, as a grave dereliction of duty. Instead of holding the Peak district in trust against the day when it becomes a national park, the Minister has permitted great harm to be done to the amenities of the Hope Valley. Apart altogether from the merits or demerits of the proposal to insist on the use of something in the nature of the Lodge–Cottrell precipitator to mitigate the dust nuisance as a condition of the extension, or of the possibility of replacing the proposed 400-ft. chimney by a 200-ft. chimney, it is clear that the Minister has neglected the comprehensive examination of mineral development in the vicinity of Buxton and the High Peak which he began in November 1946, and that he has no general plan upon which to work when dealing with individual applications for development which are already alarmingly numerous.

This is the real point of the indictment, which is not wholly met by the Bill just introduced. Mr. F. Marshall, formerly of the Ministry of Town and Country Planning, indicated very clearly the importance of the Hope Valley to the proposed national park of the Peak, and the way in which the cement works is already destroying the beauty of the valley. Protests from the Sheffield and High Peak members were supported by others on behalf of the citizens of Nottingham, Derby and Leicester. In replying, the Minister declined to reconsider his decision; but he stressed the determination of the Ministry to see that in this and in any future workings, not only should restoration be effected so far as possible while working continued, but also the actual working should be carried out in the least injurious manner.

Restoration or palliation, though welcome, is not, however, the particular point at issue. Somewhat injudiciously, perhaps, Mr. Molson had also referred to the great destruction in Ashwood Vale which the Minister is permitting without proper opportunity for public inquiry. This charge was irrelevant to one of dereliction of duty in regard to a national park area; but Mr. Silkin dismissed it all too summarily, particularly in view of the recent transfer from the regional planning controllers to the local planning authorities of the responsibility for notifying interested parties of proposals under consideration. The regional planning controllers have been scrupulous in informing such bodies as the amenity societies at an early stage, and it cannot be too strongly emphasized that early information is essential if such societies are to state their case effectively and advance constructive proposals with the best chance of success.

There is no evidence that the Minister has laid on the local authorities a like responsibility; but what stood out most clearly from this debate is not simply a lack of zeal or will but a lack of power on the part of the Government. The Minister of Town and Country Planning has the invidious, if not impossible, task of being required as a departmental Minister to decide between competing departmental and other claims to the use of land for training purposes, amenities, industry, agriculture, water-supply, mineral workings, housing, etc. He has not the authority to resist the claims of another department, being only *primus inter pares*. The balancing of such conflicting claims can only be done at Cabinet level, and in the absence of such a Cabinet committee as has been repeatedly urged in these columns the piecemeal destruction of Britain's scenic heritage, her flora and fauna and her amenities for recreation and health will continue apace.

There have been repeated instances of this danger in recent months. The Government has approved, for example, the War Department's proposals to use 1,100 acres of land, with a sea danger area, at Ross Links, Northumberland, as an anti-tank gun range, in spite of the proximity of Holy Island, the bird sanctuaries at Ross Links and the Farne Islands and of the historical associations of the district. It is held that the range will not have any serious effect on the bird sanctuaries; but that is a point which might well have been left for the Nature Conservancy to determine. Similarly, the opposition of between forty and fifty local authorities and interested bodies at a public inquiry into proposals by the War Department and the Ministry of Supply to requisition 1,660 acres of Cannock Chase for a Territorial Army training area and a tank-testing ground appears to have been fruitless, departments once again being allowed to judge their own cause.

The decisions announced earlier by the Ministry of Town and Country Planning regarding the War Department proposals for the use of Fylingdales Moor and Redesdale will likewise undermine public confidence in the Ministry's power or determination to safeguard amenity. The area to be used under the former proposal has indeed been reduced by a 950-acre coastal stretch to 28,190 acres; but the application was resisted by all the local authorities concerned, as well as by the National Farmers' Union and the Council for the Preservation of Rural England. The extension of 5,700 acres to the Redesdale artillery range, which has been approved, subject to boundary readjustments and provisions in the interests of ramblers and climbers, cuts across the Pennine Way and into the area proposed for a Cheviot National Park in the Dower Report. This consistent failure of any of the public inquiries into training areas proposed in potential national parks to secure a decision in favour of the objectors only confirms the impression that departments are allowed to judge their own cause.

Nor has the Ministry of Town and Country Planning shown itself any more alert in the defence of villages such as Letcombe Bassett, where what is at stake is the preservation of an ancient village community. The Ministry does not appear to have intervened even to the extent of referring the proposed destruction to its own advisory Committee on Historic Buildings. The security of much of the beauty of the valleys of North Wales, like the continued freedom of the Lake District from overhead lines, has depended on the reasonableness of the British Electricity Authority rather than on any authority or intervention of the Ministry itself. Even such reasonableness has not prevented the formulation of proposals such as that which would have destroyed the beauty of Guy's Cliffe, Warwick, by erecting a generating station at Hill Wootton, although six alternative sites are stated to be available. This particular proposal was promptly repudiated by the British Electricity Authority. The Council for the Preservation of Rural Wales did well to sound a warning, in its annual report, against the idea that the vigilance of its members can be relaxed now that the Town and Country Planning Act has become law. At the annual meeting of the Council at Bangor on January 14, determined but constructive opposition was manifested to features of the power scheme for North Wales, which would turn the Snowdon area into a gathering ground and make a travesty of the idea of a national park.

One of the most encouraging features of the last year is indeed the increasing alertness of the local authorities to the claims of amenity and beauty; and now that the struggle to see that such claims are not thoughtlessly and invariably overridden by the claims of utility is transferred to a new arena, such vigilance will be an important factor in enabling the amenity societies to make effective representations, when the Minister of Town and Country Planning places on the local planning authorities the responsibility which was formerly so scrupulously discharged by the regional planning controllers. This tendency is illustrated by several protests made against the Halifax Corporation Bill, which seeks powers to build a reservoir in the Hebden valley and involves a property only recently given to the National Trust by Lord Savile. The West Riding County Council and the Hepton Rural Council have united with the Hardcastle Crags Preservation Society in opposition which is regional even more than local. Again, at a recent conference to consider the War Department's claims for Angelzarke moors or Hailstorm Hill in Lancashire as training grounds for the Territorial Army, eight local authorities, together with two water-boards and two planning boards, were united in opposition. The second site had the support of the Lancashire branch of the Council for the Preservation of Rural England in a comparative statement. The conference indicated the need for a competent authority, such as the proposed National Parks Commission, at a much higher level which could take an independent view and decide between competitive needs on national and not on sectional grounds.

The National Parks Commission, moreover, should do much to remove the misunderstandings and bitterness which is at present arising between the agricultural interests and those of industry, water-undertakings and urban expansion. The new towns policy and the more effective planning of the use of land has, in fact, already decreased the risk of waste of agricultural land. Nevertheless, the extension of iron ore excavation in Northamptonshire is a source of growing concern to agriculture in a county which has in this way already lost 3,000 acres of rich farm land in the last fifteen years, and has another 60,000 acres threatened by applications in the hands of its planning officer. Here again it is understood that the whole matter is being considered by a committee representing all interests which has been set up by the Minister of Town and Country Planning, and which will have in mind the possibilities of restoration. The steel firms have already joined with the War Agricultural Executive Committee in an experiment which seeks to establish whether a fertile topsoil can be created by the use of artificial fertilizers on a 'valley' site of thirty acres near Corby.

It can no longer be contended that opposition to the proposals for training areas, water-power and other development schemes is factitious and unconstructive. There is no evidence that the Services have ever considered the joint use of training areas, or that in spite of the White Paper any attempt has been made by the individual Services to co-ordinate their own demands. The Minister of Defence has failed, or refused, to use his authority to see that Service demands are properly sifted and co-ordinated before they are submitted to an interdepartmental committee at all; and meanwhile it is evident that the Minister of Town and Country Planning is as incapable of resisting piecemeal demands and encroachment as he is, in the absence of a real policy of industrial location, of giving a clear lead to local planning in such industrial areas as the Hartlepools or the West Midlands.

The publication of the survey and plan for the Hartlepools has strikingly revealed the weaknesses of that aspect. The Government is still attempting to pursue two conflicting and incompatible policies; for whereas the planning of industrial location is essentially a national and regional function, the planning of where people are to live is in the hands of local authorities. Until the Government finally determines which policy for industrial location it means to pursue, and until regional planning authorities are established, much of the excellent work being done by town-planners will continue to be misdirected, and the waste of agricultural land, amenity and scenic beauty will be enhanced.

The absence of a central policy is the real danger in this whole question of national parks, land use and amenity. In its last annual report the National Trust emphatically endorses the view that the stronger and the more independent the national parks commission can be made, the more likely are the national parks to be a success. Furthermore, the Council of that body expresses the hope that legislation to establish a Nature Conservation Board and a Biological Service and to set up the whole organisation for national parks will be based upon the excellent reports from the Hobhouse and the Huxley Committees; a preliminary consideration of the new Bill suggests that, in the main, this has been done.

It is manifestly unfair and unwise to expect local authorities to take a national, or even a regional, view in the administration of national parks, to maintain uniform standards and to resist encroachment of other interests often of more influential national bodies or State departments; but there is no lack of opportunity for local interest and support, if amenity is to be preserved and the national parks and Nature reserves are to serve their purpose. The National Trust in the report already quoted appeals for local support in raising the standard at which National Trust properties all over Britain are maintained, and the report of the Council for the Preservation of Rural Wales, directing attention to the need for a well-informed body of public opinion, notes that in at least three Welsh counties representatives of the Council have already been nominated and accepted as members of the county planning committees.

A number of factors have no doubt contributed to the delay in the appearance of the National Parks Bill, one of them being the apparent lack of decision by the Government regarding the urgency of the situation. Meanwhile, as has been shown above, the piecemeal process of dealing with individual areas as the need arises and with little evidence of any guiding principles has led to encroachment and general dissatisfaction. It is to be hoped that the new Bill will quickly become law, and a strong National Parks Commission be set up which will be able to afford the Minister of Town and Country Planning authoritative advice. Provided he is supported effectively at the highest levels of the Government, and with the aid of the Nature Conservancy and its Biological Service, an important step forward will have been taken towards safeguarding the dwindling reserves of the flora, fauna and scenic beauty of Britain.

A THEORY OF PROBABILITY

Theory of Probability

By Prof. Harold Jeffreys. (International Series of Monographs on Physics.) Second edition. Pp. viii+412. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 30*s.* net.

THE first edition of this now famous treatise appeared in 1939, and the review in *Nature* in the following year by Mr. M. G. Kendall gives a good account of the theory developed by Prof. Jeffreys. I shall therefore give here only a general comment on the point of view adopted in the work, while noting also some of the new features of the present edition.

To many to-day it appears that the classical 'calculus of probabilities' needs to be separated into two quite distinct components:

(1) *The theory of uncertain inference.* This may be described as an extension of traditional logic; in it a probability-number is a numerical measure of the degree of 'reasonable' belief in some proposition, in relation to a given body of evidence. One role of the theory is the provision of a critique of the whole of natural philosophy, and in particular it is relevant whenever a mathematical model is selected for the description of some physical or biological situation, and also whenever a 'prediction' made with the aid of such a model is to be interpreted in relation to one's belief about the real world.

(2) *The theory of chance phenomena.* Not all empirical situations can be appropriately described by mathematical theories of the deterministic type used, for example, in classical mechanics, and sometimes it appears more appropriate to employ a mathematical model involving the notions of random variable and random process. Here a probability-number between 0 and 1 is an ideal element of the model which corresponds in the 'real' world to the value which an observed frequency-ratio appears to be approaching as the number of trials is increased, while a probability-number equal to 0 or to 1 corresponds to 'practical' impossibility, or certainty, respectively. It is these two 'conventions of interpretation' which are used to relate a particular model of this kind to the corresponding empirical situation. The decision to construct such a model for a particular situation will, of course, only be made if the observed frequency-ratios do appear to approach stable values. Accordingly, the fact that the model itself admits a representation of an infinite sequence of trials raises an important question of consistency which is answered satisfactorily by the theorem known as 'the *strong* law of large numbers'.

It follows, if this analysis be accepted, that the theories (1) and (2) should be developed independently; and that (2) shares with every other branch of natural philosophy its relationship to (1). Moreover, (2) will retain its significance even for those who reject some particular (or every) attempt to give a rigid form to (1).

Prof. Jeffreys has provided us with a theory of inference; but he appears to refuse to the mathematical theory of chance phenomena an independent status. This seems to me unfortunate, especially as (2) is more important to the man of science than (1) if he is content to make the inferences relating theory to practice in a manner at once more personal and less formal than that advocated in the work under review.

It might be held that while the notion of chance appears to be an essential element in our description of the world, it is really a reflexion of our own ignorance. If this view is correct, the theory (2) must have its place within the framework of (1); but it would presumably still retain a self-contained validity as a mathematical description of what is observed. Epistemology is likely to lag behind the descriptive achievements of natural philosophy, and accordingly the independent development of a theory of chance phenomena would still seem to be worth while. Prof. Jeffreys, however, will have none of this, for he remarks that "the essence of the present theory is that no probability, direct, prior, or posterior, is simply a frequency".

Of the new features of the second edition of this book, the most interesting is the author's account of his 'theory of invariance'. The aim of this is the provision of a universal basis for the formal description of ignorance needed in the treatment of the problem of estimation by the methods of inverse probability. In the first edition, an unknown location parameter, θ, of unrestricted range was given a prior probability proportional to $d\theta$, while an unknown scale parameter θ of range $(0, \infty)$ was given a prior probability proportional to $d\theta/\theta$. Both the arbitrariness of this procedure, and its lack of invariance for functional transformations of the parameter, have been much commented upon; the theory of invariance goes a long way towards removing one of these objections by providing a rule for the prior probability, which remains unchanged in form for all non-singular transformations of the parameter. The following remarks will illustrate its working in a simple case: let

$$\varphi(x;\,\theta)\,dx \qquad (-\infty < x < \infty)$$

be the probability distribution for a single observation; then if the prior probability for the range of parameter-values $(\theta,\ \theta + d\theta)$ is taken to be proportional to

$$\left\{ \int_{-\infty}^{\infty} \frac{1}{\varphi} \left(\frac{\partial\varphi}{\partial\theta}\right)^2 dx \right\}^{1/2} d\theta, \qquad (1)$$

the required invariance property will obtain, and when the parameter is one of scale or of location the earlier rules follow as special cases.

An extension of the rule to multi-parameter problems is given, but Prof. Jeffreys stresses the need for further investigation. It seems likely that the methods he has introduced here will also suggest interesting developments in other approaches to the problem of estimation; thus the integral occurring in (1) plays an important part in Prof. R. A. Fisher's theory of 'statistical information', while (following suggestions by Diananda and Perks) some comments are made in the present work on the relation of maximum likelihood to invariance theory.

The book concludes with a number of new tables and with an appendix on the consistency of the product rule. The first edition contained a very useful appendix on the properties of the factorial (that is, gamma) function; this has been omitted, but an equivalent account has been published separately (in "Methods of Mathematical Physics").

Only to those few who are not familiar with the 1939 edition need it be said that this is a profoundly interesting book of the greatest originality. No one who is seriously interested in the subject can afford not to read it. DAVID G. KENDALL

A TEXT-BOOK ON FUNGI

The Fungi

By Frederick A. Wolf and Frederick T. Wolf. Vol. 1. Pp. x + 438. 36s. net. Vol. 2. Pp. xii+538. 39s. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, 1947.)

THERE is a great demand among university students in botany for modern text-books dealing with the fungi. Broadly speaking, two works are needed: a relatively small book dealing briefly but clearly with the morphology and reproduction and also discussing the physiology, ecology and cytogenetics of fungi, and a larger work, probably running into several volumes, dealing with the structure, reproduction and taxonomy of fungi along the lines of Fritsch's classic on algæ.

The publishers' announcement heralding the appearance of F. A. Wolf and F. T. Wolf's two volumes led many teachers of botany to hope that this new work would satisfy a very real want; unfortunately, the books have proved a disappointment. Volume 1 is so different from volume 2 that a reviewer must treat them separately. The former aims at giving the student a picture of the developmental morphology and classification of fungi. Clearly, in 438 pages it is not possible to be exhaustive, and the authors have deliberately omitted certain families; but the omission of all reference to Drechsler's beautiful work on Zoopagaceæ and to Winge's classic researches on haplophase and diplophase in yeast are difficult to excuse.

It is the modern fashion to condemn the 'type' method in teaching, and certainly Wolf and Wolf are modern in this respect. From their book it would certainly be very difficult for the student to gain any really clear picture of the structure and life-history of any single fungus. This difficulty is increased by the fact that the numerous black-and-white illustrations are merely scattered about the text as decorations, the authors having deliberately refrained from making reference to them in the text. Perhaps the best part of volume 1 is the treatment of the Ascomycetes; but in the Basidiomycetes the Hymenomycetales are dismissed in twenty pages and, instead of a careful comparative account of structure and development, the student is presented with a very inadequate discussion of the characters used in the delimitation of genera. Again, the section on Phycomycetes leaves much to be desired, and there are errors both in the figures and in the text. We are told that the chytrids are characterized by anteriorly uniflagellate zoospores; bi-flagellate zoids are seen escaping from the zoosporangium in Fig. 22 which represents *Blastocladia*, and the structure of the sporangium of *Rhizopus* (Fig. 35) is distinctly odd.

The mycologist having perused volume 1 turns with relief and hope to volume 2, since the list of chapter headings gives real promise. This volume consists essentially of a series of essays on mycological subjects, such as: nutrition of fungi, biochemistry of fungi, spore dissemination, germination of spores, host penetration, physiological specialization, mycorrhiza, genetics of fungi, poisonous and edible fungi, medical mycology, soil fungi, fungus-insect relationships, marine fungi and fossil fungi. Each essay has a good list of literature at the end, and these lists probably represent the most useful part of the whole work. But the essays themselves are disappointing, and errors are easy to find. It would have been better had the authors discussed fewer topics in a more careful and discriminating manner.

The volumes are well printed, strongly bound and the text-figures are clear; but, even if the work could be recommended to students, the price is much too high. C. T. INGOLD

SELECTED PAPERS OF C. O. JENSEN

Selected Papers

By C. O. Jensen. (Published at the expense of the Rask-Ørsted Foundation.) Vol. 1: 1886–1908. Edited by M. Christiansen and H. O. Schmit-Jensen. Pp. xvi+681+14 plates. (Copenhagen: Einar Munksgaard, 1948.)

THIS collection of papers represents the scientific activities of C. O. Jensen during 1886–1908, and is to be followed by a second volume covering the period 1909–33. Thirteen of the papers which were originally published in Danish have been translated into excellent English. The remainder are reprints in German and one in French.

Most of the work was done in the Bacteriological Department of the Laboratory for Agricultural Research, Copenhagen. A short biography, in English, by M. Christiansen, adds point to the collection. A period of three years illness forced Jensen to give up his veterinary practice and take a sedentary job in bacteriology, and this greatly influenced his scientific career. He was fortunate in having for his teachers Salomonsen, who also trained Fibiger, with whom Jensen was associated in several investigations, and for a time in Berlin, Robert Koch.

Jensen succeeded Bang, and for forty-five years lectured on bacteriology and serology. Living at a time when bacteriology was making rapid strides, it is not surprising that Jensen was able to produce a great many valuable papers on milk control and various animal diseases. To the medical reader, the greatest interest probably will centre on his advocacy of pasteurization and hygiene in the dairy industry. Jensen identified the causes of the turnip flavour in milk and butter, which he showed to be due not, as then believed, to the cows' diet but to contamination of the milk after milking by various specific bacteria. He saved the Danish dairy industry a great deal of money, and made notable contributions to public health and to veterinary science. A period of collaboration with Fibiger helped to establish the relationship of human and bovine tuberculosis. To the writer, however, Jensen's work on experimental cancer is of the greatest interest. This subject is covered by six papers, five of which are translated into English from the original Danish.

Jensen established a number of transplantable tumours of mice and a transplantable sarcoma of the rat, generally called the 'J.R.S.', which is still widely used because of its consistent biological characteristics.

Many of the now well-known properties of tumour cells were first described by Jensen, who showed experimentally that they could not resist temperatures above 46° C., actinic light from a Finsen lamp with adequate cooling of the tumour tissue, drying and autolysis, and, in fact, that cancer cells had general properties very similar to those of normal cells. He failed to demonstrate any infective or parasitic causal factors associated with his transplantable tumours. In a lecture on "Some Experiments with Cancer Tumours" in 1901, Jensen discussed the etiology of cancer in terms that are equally apposite to-day.

Jensen's objective attitude towards his own work is well illustrated by his frank admission in a paper (1908) that his earlier claims, in 1905, to have caused regression of transplanted tumours by injection of antiserum obtained from rabbits immunized against mouse tumour were ill-founded, and that the regressions were probably spontaneous.

Jensen recognized the desirability of investigating the incidence of spontaneous tumours in the progeny of mice bearing spontaneous tumours. He attempted some experiments on these lines; but as the significance of line breeding was not then appreciated, his results were less striking than those of modern geneticists.

This collection of papers is an example of consistently good experimental work, lucidly expounded.

P. R. PEACOCK

SPECTROSCOPY AND ITS APPLICATIONS

Spectroscopy and Combustion Theory

By Dr. A. G. Gaydon. Second edition, revised. Pp. xii+242. (London: Chapman and Hall, 1948.) 25*s*. net.

Hyperfine Structure in Line Spectra and Nuclear Spin

By Prof. S. Tolansky. (Methuen's Monographs on Physical Subjects.) Second edition, revised and enlarged. Pp. viii+120. (London: Methuen and Co., Ltd., 1948.) 6*s*. net.

BOTH these books are revised second editions of well-known and valuable monographs. They deal with the detailed application of experimental and theoretical spectroscopy to the specialized problems of chemistry and physics. Both are written by acknowledged authorities in their respective fields, and contain fairly complete reviews of the original contributions of the authors.

Combustion processes are extremely fast chemical reactions, and kinetic studies have shown that many are chain reactions involving the intermediary participation of atoms, radicals or energy-rich molecules. Direct measurements of the nature, formation and reactivity of these active particles are not straightforward, and it is in this field that spectroscopic studies can reveal much information not obtainable in other ways. In his monograph, Dr. A. G. Gaydon has summarized the progress that spectroscopic research has made in the study and elucidation of the finer details and mechanism of the combustion process. Much of the material is the original work of the author, and in preparing the second edition the book has been considerably expanded and brought up to date by the inclusion of new material. Those who found the first edition valuable will not hesitate to read this new modernized version. To others interested in combustion the book can be warmly recommended as a most stimulating work and the only book which summarizes the great advances which the application of theoretical and experimental spectroscopy have made to the theory and nature of combustion. The subject-matter is presented in an elegant, precise and readable manner, and no detailed previous knowledge of spectroscopy by the reader is assumed. The early chapters, which deal with the study of the emission spectra of various flames and explosions, are followed by chapters devoted to continuous spectra, the role of atomic oxygen in flames, and the use of absorption spectra and investigations in the infra-red region in studying combustion processes. Later chapters are devoted to special topics such as after-burning, determination of flame temperatures, and the life-time of activated molecules. In the last section the author indicates possible future developments and the nature of the problems yet to be elucidated. A fairly complete bibliography and an appendix, giving the chief characteristics of the flame spectra which have been studied, are included and have enhanced the value of the work as a reference book.

Prof. S. Tolansky's small book is one of the well-known series of monographs on physical subjects published by Messrs. Methuen. It is intended for students who are already familiar with the fundamentals of atomic spectroscopy and who wish to enlarge their knowledge and become familiar with the important developments which have arisen from the detailed study of the theoretical and experimental aspects of the hyperfine structure of line spectra. Since the first edition of this work, considerable advances have been made, and these are included in several new chapters and by the extensive rewriting of other sections of the book. Because the hyperfine structures of the spectral lines are due to either isotopic mixture or spin properties of their nuclei, recent developments have been largely concentrated on providing information about nuclear and magnetic moments. It is with this aspect that the book is mainly concerned. The determination of these magnitudes is summarized in a clear and concise manner, and an up-to-date list of nuclear data of some fifty-five different atoms, including seventy-nine isotopic species, is provided and discussed. An adequate theoretical background for the understanding of the hyperfine structure is given.

The advanced student or others interested in either spectroscopy or nuclear structure will find this book easily readable and useful. It can be thoroughly recommended as an excellent introduction to the subject.

The Cinnamon Bird

By R. M. Lockley. Pp. 79+4 plates. (London: Staples Press, Ltd., 1948.) 8*s.* 6*d.* net.

R. M. LOCKLEY is one of the best-known of British naturalists. He is an accurate observer, and his prose is so good that any book of his is pleasant to read, even by those who have little knowledge of the subjects on which he writes. In "The Cinnamon Bird" he tells of an experiment made of taking a dozen marked canaries from captivity to his small, wind-swept island of Skokholm in the Irish Sea, a home of shearwaters and an alighting place of many migrants. Here the small birds were gradually given full liberty, and the record of their lives on the island during the spring, summer and autumn is set down. By September the population of canaries had increased, and the young birds flew over the island in little flocks or 'charms', happy and carefree. But in September came disaster, for the island is visited each year by numbers of sparrow hawks, and these gradually thinned the numbers of the canaries until those which were not caught and housed once more had all been killed. One of the canaries had a brief mating with a migrating goldfinch, which next morning left the island. She laid four eggs, but only one hatched. The hybrid was a cock, a beautiful and strong bird, with a rich song differing slightly from a canary's song. One of the most moving passages in the book describes the son's furious pursuit of the hawk which killed his mother. There are four excellent illustrations in colour by C. F. Tunnicliffe, which are admirably reproduced, and the printing and appearance of the book generally are unusually good. In this short notice I have been able only to touch on the book's contents, which will be read with appreciation by R. M. Lockley's wide circle of admirers. SETON GORDON

Compendio y descripción de las Indias occidentales

Por Antonio Vázquez de Espinosa. Transcrito del manuscrito original por Charles Upson Clark. (Smithsonian Miscellaneous Collections, Vol. 108: Publication 3898.) Pp. xii+801. (Washington, D.C.: Smithsonian Institution, 1948.) n.p.

THIS thick volume is a transcription of an unidentified manuscript found in the Vatican by Mr. C. U. Clark in 1930 and afterwards ascribed without any doubt to the Carmelite Fray Antonio Vázquez de Espinosa. Mr. Clark edited it and translated it into English, and this version appeared in 1942 as vol. 102 of the Smithsonian Miscellaneous Collections. It proved impossible to carry out the editor's original intention of publishing the Spanish text opposite the translation, and its appearance six years later cannot but be somewhat of an anti-climax to English readers. The work itself is a description, mainly geographical in the widest sense, of Central and South America and the Philippines, and it includes matter for the anthropologist, the botanist and the historian; however, the author does not claim special historical knowledge—in fact his remarks about the Inca Atahuallpa show less of knowledge than a desire to vindicate his countrymen. The editor considers that the greatest value of the work lies in the picture it gives of contemporary Spanish colonial and ecclesiastical administration at a period which is not adequately covered by other writers.

The book was written in 1628, and internal evidence shows that Vázquez's travels lasted over at least the years 1612–21. He gathered much of the information himself, covering a surprising amount of country in lands where travel has always been difficult and full of hardship. He was at pains to learn from eyewitnesses about regions which he could not visit, and his information, though necessarily variable in the amount of detail given, rings true in the ears of a modern traveller who knows a few of the places he describes. G. H. S. BUSHNELL

Some Notes on the Psychology of Pierre Janet

By Elton Mayo. Pp. ix+132. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 14*s.* net.

IN his researches into human problems in industry, Prof. Elton Mayo has been considerably influenced by the work of Pierre Janet, the French psychologist. Janet's findings have been less well known in the English-speaking countries than on the Continent, since few of his important works have been translated into English. To help those who wish to read Janet in the original French as an aid to their studies of society or of industry, Mayo has brought together some notes which were originally prepared for his colleagues at the Harvard Graduate School of Business Administration whose work demanded close attention to the difficult individual, social and administrative problems of our time. For many years Janet's clinical contributions to psychopathology have been dismissed somewhat cavalierly as something which has been superseded by Freudian and other developments. Readers of these notes will find that there is little real conflict between the observations of Janet and Freud, and that Janet's investigations into the restricted field of obsessive thinking are in many ways mutually complementary to Freud's more widely ranging hypotheses. The book, written with Mayo's usual enthusiasm and sincerity, also includes his address to the Harvard Medical School on "Frightened People", in which he describes the causes of fear in individuals and the need for effective re-assurance in the consulting room. T. H. H.

Proteins and Amino Acids in Nutrition

Edited by Dr. Melville Sahyun. Pp. xvi + 566. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 45*s.* net.

THIS collection of articles, by various experts, some of them having the standing of international authorities, covers a wider field than one could infer from its title. It is a long way from the feeding of pregnant women to the size of particles found in rabbit papillomas. The only connexion is that both have a *p* in them, the *p* standing for protein. This is essentially a book for libraries and is in some ways an essential book for libraries; many who cannot be expected to pay its rather high price for very occasional use will want to consult it from time to time, until the day when, like all such compilations, it has become too out-of-date to have anything but historical value. This will be small, for it bears no impress of individual personality or even of editorial policy; it is rather a friendly symposium, at a high technical level, unhampered by fear of the chairman's gavel. Names such as H. H. Mitchell, Lela Booher, H. J. Almquist, Clarence Berg and the editor himself guarantee, however, that the contributions to the symposium will—etymology notwithstanding—be full of meat. From the British reader's point of view, however, the 94 pages of appendix are almost complete waste of space. A. L. B.

PIERRE SIMON LAPLACE (1749–1827)

By Dr. S. LILLEY

St. John's College, Cambridge

DESPITE the immensity of his achievement, Newton had scarcely done more than pose the problem of explaining the observed behaviour of the solar system in terms of his laws of motion and the inverse square law of gravitation. Until the full complexities of the observed behaviour of the planets and their satellites had been shown to be deducible from the Newtonian laws, philosophers might (and sometimes did) doubt whether gravitation alone was a sufficient principle of explanation in celestial mechanics. The task of completing the Newtonian celestial mechanics was largely carried out in the century after Newton's death by French mathematicians, and above all by Laplace.

Of Laplace's great book, Grant remarked, "The physical theory of the planetary system is exhibited in the *Mécanique Céleste* in a state of almost complete development"[1]. There were details to be filled in, of course—even some that required prodigious efforts of thought and calculation, like the explanation of Saturn's vagaries by the prediction of Adams and Leverrier in 1845–46 that they were caused by a yet undiscovered planet, Neptune. There were mistakes to be corrected—a fortuitous coincidence with observation, which Laplace had obtained by neglecting non-negligible quantities in his explanation (1787) of the moon's secular acceleration in terms of the changing ellipticity of the earth's orbit, was only pointed out by Adams in 1853. But by and large, Grant's assessment is correct, provided we substitute the word 'Newtonian' for 'physical' in the sentence quoted; for the main nineteenth-century advances were made by taking into account physical phenomena—such as tidal friction—not contemplated in a purely Newtonian scheme. It was by tidal friction that the error regarding the moon's secular acceleration, for example, was eventually cleared up by Delaunay.

Pierre Simon Laplace was born of a Normandy peasant family on or about March 23, 1749, and died on March 5, 1827. There is sufficient of a seamy side in his personal and political life (for, like many French scientific men of his times, he took part in politics during and after the Revolution) to make it advisable in a short note to give no more of his biographical details.

The scope of Laplace's astronomical work makes it impossible to do more than mention some of his contributions. With Lagrange, he accounted for most of the outstanding planetary inequalities. His improvements in the lunar theory were immense—particularly the entirely new mode of treatment which he introduced in the third volume of the "Mécanique Céleste". Even his only partially correct explanation of the moon's secular acceleration was a great achievement, since the problem had baffled others so completely that Lagrange, for example, had been led to doubt the observations. He took a first step towards Maxwell's elucidation of the structure of Saturn's rings when he showed that they could not be uniform solid bodies. He introduced a dynamical theory of the tides, an enormous advance on the statical theories that had preceded it, though still inadequate to describe the physical realities of tides on so complicated a surface as that of the earth.

But Laplace's most impressive achievement was the series of researches, conducted in competitive co-operation with Lagrange, that led to the demonstration of the stability of the solar system. Beginning in 1773, these researches passed through such steps as the explanation of the inequalities of Saturn and Jupiter, to the two following remarkable propositions:

(1) Take for each planet the product,

$$\text{mass} \times \sqrt{\text{axis of orbit}} \times (\text{eccentricity})^2.$$

The sum of these products over all planets is invariable.

(2) The proposition obtained from (1) by substituting the tangent of the inclination of the planet's orbit for its eccentricity is likewise true.

In each case the truth of the proposition depends on the fact that all the planets revolve in the same direction around the sun. Since both these quantities are known to be small at the present epoch, it follows that, under Newtonian assumptions, the eccentricities and inclinations must always remain small. In other words, the solar system will continue indefinitely in something closely approaching its present form.

In his "Mécanique Céleste" (1799, 1802, 1805, 1825), Laplace gave an exposition of all existing knowledge of physical astronomy. The book exhibits the solar system as a vast and complex machine, every movement of which is a mere working out of the laws of mechanics and gravitation, while its continued functioning for an indefinite period is guaranteed by the two propositions on stability referred to above. Napoleon, according to a favourite story, remarked to Laplace that God was nowhere mentioned in his work; and Laplace replied, "Je n'avais besoin de cette hypothèse-là". It was this aspect of Laplace's work that most struck his contemporaries. An age that was still dominated by natural theology could not but be shocked at the idea of a universe so perfectly mechanical as not to require Providential intervention to ensure its continued working, or at least special planning by the Creator at the time of creation to ensure that the machine would work indefinitely. Astronomical treatises of the time, and especially popular and semi-popular presentations in encyclopædias and the like[2], devote much space to showing that Laplace has not abolished the 'argument from design'—the fact that the demonstration of stability depends on the rotation of the planets all in one direction is taken as an argument that they must have been designed to do so; the inverse square law is somewhat heatedly asserted to be a matter of Providential design and not, as Laplace and others would have it, an essential attribute of central forces; and so on.

This opposition emphasizes one of Laplace's more general contributions to thought: his enormous astronomical achievements were among the most important of the factors which slowly drove teleology out of science during the course of the nineteenth century. (On the negative side, the success of celestial mechanics must bear a share of the blame for the extreme mechanistic attitude that permeated later nineteenth-century physics.)

Another contribution to this wider sphere of thought came from Laplace's nebular hypothesis for the origin of the solar system, which he propounded only half seriously in his "Système du Monde" (1796). Inadequate to explain the actual facts, it nevertheless helped to establish the conception of a universe which evolves historically through long periods of time, in place of the static, unhistorical world-view that had hitherto dominated European thought, with its correlative belief that the world was only a few thousand years old. The nebular hypothesis took its place along with the first significant attempts at evolutionary theories in geology (Hutton, 1785) and in biology (Erasmus Darwin, 1794, and Lamarck, 1801) in making the first breaches in this unhistorical universe. (The almost simultaneous appearance of these three theories is probably not entirely independent of the ideas about social evolution that became common before and during the French Revolution.)

Laplace did little in experimental science. He did, however, collaborate with Lavoisier in researches (published in 1784) which rank second only to those of Joseph Black in the foundation of calorimetry, and which led to the first clear conceptions of the relations between combustion and respiration.

On the other hand, he played an important part in the first stages of the development of mathematical physics (as contrasted with mechanics), which was to burst forth in full vigour with the work of men like Fourier, Poisson and Fresnel a few years later. Some of the beginnings of this new movement can be traced to Laplace's theory of capillarity (1805, independently developed by Thomas Young about the same time), his correction of Newton's formula for the velocity of sound (by making allowance for adiabatic compression and expansion), and his less fortunate attempts to give satisfactory mathematical formulations to the corpuscular theory of light and the imponderable fluid theory of heat.

It is the common fate of great men that their more concrete scientific contributions soon find their way into the attic store-room of 'mere history', because they are quickly superseded; while their more abstract methodological contributions may survive for centuries as the working tools of future generations. Laplace's not negligible work in such practical matters as navigational astronomy had only a short-term significance and is now almost forgotten (though the metric system constantly reminds us of another practical matter in which he took part). Much of his astronomy has also now become mere history: what, for example, can be the significance of his demonstration that the abstract universe with which he dealt is stable, when we know that the physical universe includes important phenomena like tidal friction which his work ignored? But some of the mathematical tools which Laplace invented or developed in the course of his researches came to be among the everyday working tools of mathematical physicists, and remain so to-day.

Laplace had almost no interest in mathematics as such. It was to him just a tool for solving physical problems. Hence his mathematical style was far from elegant, and often very obscure. It is, furthermore, difficult to distinguish precisely his own mathematical discoveries, since he borrowed unashamedly without acknowledgment. The concept of potential he got from Lagrange, and even the famous 'Laplace's equation', $\nabla^2 V = 0$, where V is the potential, occurs in hydrodynamical researches by Lagrange so early as 1760. But it was Laplace's use of these tools in gravitational problems that demonstrated their power, so that the attaching of his name to that now ubiquitous equation is perfectly justified. He also made notable contributions to the special functions occurring in boundary-value problems. In fact, many of the partial differential equations that became important in the nineteenth century and much of the mathematics of boundary-value problems arise directly or indirectly from Laplace's work. From the potential theory one can trace, for example, a connexion to Riemann's special approach to the theory of functions of a complex variable, and thence to one of the sources for the development of topology. In similar ways one could, if the search were worth the trouble, find part of the sources of much nineteenth-century mathematics (which the twentieth century still uses) in the work of Laplace. Another mathematical tool still in everyday use is Laplace's rule for the expansion of a determinant, which he gave in a clumsy form in 1772.

Laplace's work on the theory of probability was again derivative in the first place from his astronomical work; but in this case he did go on to develop it for its own sake ("Théorie Analytique des Probabilités", 1812). This is usually considered as the greatest contribution by any one man to probability theory. Laplace had earlier discovered the normal error law. But his most important advance is his consistent and extensive use of continuous probability distributions, which had made only rare and sporadic appearances with previous writers. It is this point especially that entitles his book to be called the first presentation of something like a modern theory of probability in connected form.

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[1] Grant, Robert, "History of Physical Astronomy", 106 (London, 1852).

[2] For example, "Pantalogia, A New Cyclopædia" (London, 1813), article "Astronomy", cols. 13–14. I merely cite an example which happens to be on my shelves at the moment of writing.

SCIENCE AND DEVELOPMENT IN THE PACIFIC AREA

By Sir NORMAN HAWORTH, F.R.S.

THE Seventh Pacific Science Congress met at Auckland and Christchurch, New Zealand, during February 2–22, under the auspices of the Royal Society of New Zealand and its president, Dr. R. A. Falla, who presided over the Congress. The secretary-general was Dr. Gilbert Archey, director of the Auckland Museum, and Prof. R. S. Allan was chairman of the Christchurch committee. The New Zealand Government extended invitations to forty-eight countries represented in the Pacific Science Association, to the South Pacific Commission and Health Service and the specialized agencies of the United Nations and the Economic Commission for Asia and the Far East. About 220 delegates attended from overseas, and some 150 from New Zealand. Earlier Congresses have been held in Hawaii (1920), Australia (1923), Japan (1926), Java (1929), British Columbia (1933), California (1939). Their purpose has been to initiate discussions on scientific topics of special significance to the Pacific area and of importance to the welfare of its peoples. Sessions of the present Congress were devoted to discussions of major problems, particularly those demanding close co-operation between sciences and between countries, and the formulation of further research plans required to secure these aims.

In the Geology, Vulcanology and Geophysics Section, a remarkable colour-film was shown of the birth and development of a new volcano rising from the agricultural plain at Paricutin in Mexico. In a few months this volcano, amid its fringe of hot flowing lava and dust, attained a height of 1,400 ft. above the plain and submerged a village. Beno Gutenberg, of the Seismological Laboratory at Pasadena, presented a map showing the Pacific basin surrounded by volcanic and seismic activity. A systematic relationship was found between the distribution of the gravity field, deep sea trenches, island areas, and foci of earthquakes. One session was devoted to recent work on cosmic noise. E. G. Bowen gave an account of radio noise coming from the region around the sun, and suggested that the temperature of this region rises rapidly with increasing distance from the sun.

Weather forecasting in the tropics and the mechanism of typhoons were the subjects of several papers in the Meteorology Section. If a sufficient number of tropical weather stations were available, one of the most fruitful methods of forecasting would be to measure the convergence of surface winds with the view of finding where the air was rising. Major W. S. Barney, of the U.S. Air Force, described how, during a recent typhoon which swept over the Philippines, weather reconnaissance squadrons determined its centre from day to day during December 2–10, 1948. They found that at 10,000 ft. they were above the violent part of the storm. In the centre was a calm circular area some twenty miles in diameter in which the sky was clear. Descending into this area to 1,500 ft. they saw the clouds in the form of a vertical wall around them. They flew into this cylindrical wall and encountered such violent up-currents and turbulence that their aircraft was damaged despite its great strength. The physical features which determine the course of tropical cyclones were discussed. From an analysis of upper air data, R. H. Simpson, of the U.S. Weather Service, suggested that at some 15,000 ft. the isotherms are circular except for a tongue of warm air which projects in the direction towards which the storm is moving.

On the general circulation of the atmosphere, C. H. B. Priestly described how upper air data can be used to calculate the flow of heat and momentum over the whole of a parallel of latitude. The difference between the amounts flowing over two such circles of latitude was accounted for by absorption at the earth's surface in the area between them. Sir Geoffrey Taylor contributed a paper on convection currents in the atmosphere over a source of heat. He showed how laboratory experiments with a small source of heat like a Bunsen burner may be used to explain and describe the upward currents of air over a volcano or a forest fire. Instrumental techniques were described in several papers, which included an account of the upper air stations in the Canadian Arctic, the use of a balloon-borne instrument for measuring potential gradient, and the operation of meteorological balloons so controlled that they remain in given limits of height. E. G. Bowen described the artificial production of rain. The temperature of a cloud was first determined, and it was then seeded with 'dry ice' from an aircraft at frequent intervals. In most cases rain was produced when the temperature of the cloud was below the freezing point; but never when the temperature was above it.

In the Oceanography Section papers were presented in all aspects of the subject: geological, physical, chemical and biological. Among the geological studies an important feature was the abundance of new data from the survey of the U.S. Navy in the Pacific Ocean and of the Bikini Atoll. F. P. Shepard, of the Scripps Institution, reported the results of further exploration of deep-sea canyons. On the physical side it has become clear that one of the main objects of applied oceanography is to obtain a complete picture of the distribution of water of different physical and chemical properties and of the water movements. Since this is unlikely to be achieved by survey work alone, attention is being given to the fundamental processes by which radiation, wind, turbulent flow, and like factors affect the distribution and produce seasonal and other changes. Such new knowledge is imperatively needed, and its interest should attract to oceanography able mathematicians and physicists in the same way that marine biology has attracted zoologists. One such physicist, G. E. R. Deacon, was warmly appreciated for the lead he gave in a variety of problems when he described the Discovery Committee's work on surface boundaries in the South Pacific Ocean and also the researches of the Royal Naval Scientific Service on waves, microseisms and the electrical and magnetic effects of water movements and earth currents in the sea. The latter investigation revived earlier attempts by Faraday to apply this principle to the measurement of marine currents, and its success now places a new instrument in the hands of future observers. N. A. Mackintosh, the director of research of the Discovery Committee, communicated a paper on the distribution of whales in the South Pacific. Martin W. Johnson, of California, played recordings of sounds made by fish against the continual sound of the sea. The crackling sound made by the snapping shrimp, heard also through the hulls of yachts, resembled the sound of boring, or the noise of a busy factory. There were low grunts from sea-robins, while other fish made sounds like the chirping call of a bird, the mewing of a kitten, and the whirring sound of a propeller. Most spectacular were the sounds from porpoises, ranging from noises like the barking of dogs to the tuning-in whistles of a radio set. Long series of great hiccoughing noises were probably from humpback whales. Prof. C. M. Yonge, of Glasgow, gave a public lecture on the reef-building corals.

The Zoology Section covered a wide field; but the central theme was the consideration of the terrestrial, freshwater and marine faunas of the Pacific. Contacts with agriculture were made through economic entomology, and with oceanography by way of fish and fisheries and by joint discussions with these two related sections of the Congress. These talks led to a symposium on the protection of Nature in the Pacific and on the prospect of a world approach to international conservation.

There appeared to be two aspects of this latter problem. First there is the need for careful conservation in the Pacific area of the terrestrial and marine resources of raw materials and food for rapidly increasing human populations in the region. Fisheries have not yet been fully exploited, and interest centred around an American project to spend a million dollars on a survey of the marine resources and especially the tuna fisheries around Hawaii. The population of the Philippines depends almost wholly on rice and fish, and only an increased supply of the latter seems feasible as the immediate answer to the urgent problem of a rapidly rising human population.

The second aspect of conservation is the need to rescue and preserve agriculture from the ill-effects on native fauna and flora of introduced animals and plants. In the Hawaiian Islands, there are species of plants now confined to single areas and reduced to a few individuals. In New Zealand, also, innumerable problems have been created by the introduction of many species of plants and animals. Quite apart from the doubtful expedient of the original British settlers' of firing large areas of bush country as a means of clearance, widespread erosion has been caused by the destruction of mountain flora by deer, and the damage caused by opossums, goats, hedgehogs and rabbits is no less serious. No region in the world has suffered more from the effects of man's interference with Nature than the islands of the Pacific, including Australia and New Zealand. The Congress made detailed reference to these many problems and their remedies. The extermination in 1946 of the goats on the now uninhabited Three Kings Islands off the northern tip of New Zealand has resulted in the regeneration of the flora; the Islands were rapidly approaching the degree of bareness and aridity experienced in St. Helena more than a century ago. Valuable reports were presented by E. Mayr on the terrestrial faunas of the Pacific, including a survey of geological structure and geological history and their biological implications.

Distribution and utilization of marine Algæ received attention in the Botany Section. Distribution was considered to be more satisfactorily explained on the basis of continental drift than on the land-bridge hypothesis. Plant geography in the Pacific area was discussed, and attention was directed to O. H. Selling's publications on pollen studies of living Hawaiian plants and related genera elsewhere. Associated studies of the late Quaternary history of vegetation give striking indications of climatic waves in the recent history of these islands. C. Skottsberg discussed the flora of Hawaii and stressed the continental character rather than the insular, its strongest affinities being in the southerly Pacific area. Some results of recent research by the Swedish Deep Sea Expedition, and their bearing on the stability of the Pacific Ocean, were reported by H. Pettersson. H. J. Lam, of Leyden, outlined the progress of compilation of distribution maps of Pacific plant taxa. R. A. Silow, representing the Genetical Society of Great Britain, spoke on the problems of trans-Pacific migration involved in the origin of the New World cottons, and the suggestion of recent prehistoric influence from southern Asia in South America.

The section devoted to Soil Resources, Forestry and Agriculture took in a wide survey. The future of the Pacific countries depends largely on the right use of land resources. Methods of soil survey were compared, and differences were found to exist rather in nomenclature than in the actual nature of the categories. It is important to understand the genetic relationship of the soils mapped; discussions revealed a satisfactory overall agreement in aims and methods. Greater divergences appeared on the subject of land classification, where the objective is to integrate the physical, economic and other factors into a system which prescribes 'land-use capabilities'. Here the ascertainable facts are combined with personal judgment and have not the scientific accuracy of soil classifications, although examples of such land classification which had been proved accurate by experience were given. To many, 'land-use capability' is governed by erosion potential, which is a menace to be guarded against in all future land development.

In all this, forestry policy has an important place, and much time was devoted to problems affecting forestry in the Pacific area. Of exotic species tried in New Zealand, *Pinus radiata* was found to have been eminently satisfactory. Changes taking place in the general rural economy of the North Island were described by N. H. Taylor, of the Soil Bureau, Department of Scientific and Industrial Research, Wellington. This account was followed by an extensive tour in which the relation between soil, climate and the development of different systems of agricultural and forestry policy and production was clearly demonstrated. Large areas of North Island are covered by soils of fairly recent volcanic origin. The original forest was burnt off by early settlers to provide grazing lands. Lime and phosphate are the chief deficiencies where grass and clover are to be grown for intensive dairying. Despite such fertilizer treatment, scores of thousands of acres were of limited value for livestock farming owing to the intractable 'bush sickness'; but this has now been remedied by the application of cobalt salts. R. W. Phillips and C. P. Meekan opened discussions on dairy cattle improvement, and these led to lively comments. Such questions are receiving much less attention than they deserve in the Pacific countries. The outstanding developments of the Jersey for butter-fat production and of the Corriedale and other breeds for wool and fat-lamb production were, however, seen at first hand, as was also a Dutch Friesian herd of cattle with a butter-fat yield of well over four per cent.

Anthropology, Public Health and Nutrition, and Social Sciences were represented in three further sections of the Congress which often met in joint session. Sir Peter Buck, now director of the Bernice P. Bishop Museum at Honolulu, was a dominant figure; he was a medical graduate of Otago University at Dunedin, where most of his work has been done. His lectures and researches in anthropology, his book on the "Vikings of the Sunrise", and his part-Maori ancestry combined to make him the acclaimed, though modest, leader before popular audiences. V. W. T. McGusty, formerly director of medical services in Fiji, outlined the Colonial policy of administration in which primitive forms of society are protected and native medical officers are employed for the control of disease. Sir Peter Buck said this example is being followed by the United States in its trust territories in the Pacific. Similar training schools have been established at Guam which will provide native medical workers for the rest of Micronesia. E. Beaglehole, of Wellington, said that Colonial Powers are prone to believe that backward races require the same type of government as their own complex societies, whereas the islanders had a workable self-government before Europeans came, and would develop new procedures in their simple communities as their needs expanded. A. P. Elkin, of Sydney, said it has been proved that the aborigine in Australia can be led to an intelligent appreciation of the intruder's culture if his right to participate in citizenship is recognized. The report of the committee on blood groups of the Pacific area was given by H. L. Shapiro, of New York, and he also, along with

G. P. Murdoch, of Yale, outlined the anthropological studies in Micronesia. Papers on dental caries, tuberculosis and tropical diseases, together with reports on remedial measures, were contributed, and further research programmes were discussed. These sessions covered a wide and important field on medical and social problems, and represented a very live and vigorous section of the Congress. The present writer presided at a general Congress discussion on the "Social Implications of Science".

Parties of overseas delegates in groups of some twenty members were taken on conducted tours each of a week's duration through the North and South Islands. These tours were arranged to bring delegates south from Auckland to Christchurch with stops at interesting centres *en route*, and also after the termination of the Christchurch sessions. Apart from the scenic interest of these excursions by road, the delegates gained, by scientific intercourse and social fellowship, a lasting benefit comparable with, or even exceeding, that of the organised Congress itself.

In conclusion, it is a pleasant duty to acknowledge the help I have received from my fellow delegates from Britain in compiling this report, namely, Prof. G. W. Robinson, the leader; Sir Geoffrey Taylor; Prof. H. D. Kay; Prof. C. M. Yonge; Dr. G. E. R. Deacon and Dr. R. A. Silow, whose impressions, together with my own, I have endeavoured to record. These can, however, reflect only a small part of the whole work of the Congress.

PRE-STRESSED CONCRETE

In recent years there has been a growing interest among engineers in the use of pre-stressing for concrete structures, and on February 16 a conference was held at the Institution of Civil Engineers to review the present position of pre-stressed concrete. The conference was arranged under the auspices of the Institution and the Joint Committee on Materials and their Testing (a Committee representing some twenty-five technical and professional institutions and societies). The chair was taken, for the morning session, by Mr. R. H. H. Stanger, and, for the afternoon session, by Mr. W. K. Wallace.

A paper by Dr. F. G. Thomas, of the Building Research Station, had been prepared as a basis for discussion. The basic principle of pre-stressing, Dr. Thomas pointed out, consists in the imposition of preliminary internal stresses in a structure before the working loads are applied, in such a way as to lead to a more favourable state of stress when these loads come into action. The preliminary stresses induced in concrete are essentially pre-compressions, which may be uniform or non-uniform, with the primary object of avoiding cracking under the conditions of working load. In most practical cases the pre-stress is applied by stretched steel wires of high tensile strength.

A description of the early development of the technique was followed in the paper by a comprehensive survey of the basic features of pre-stressed concrete, including the materials used, the fundamental assumptions to be made in design and the various practical systems of pre-stressing. Dr. Thomas gave a brief account of the experimental investigations that have been made, and concluded with descriptions of constructional work executed in Great Britain and elsewhere. This section of the paper embraced references to bridges, tanks, reservoirs and pipes, buildings, and miscellaneous work such as tunnels, harbour construction, aeroplane runways and railway sleepers.

In introducing his paper, Dr. Thomas emphasized the need for high-quality materials to be used in pre-stressed concrete construction. Although a high strength of concrete is not always necessary, but often desirable, a high standard of quality control is essential. A high early strength of the concrete is required on economic grounds, and usually a rapid-hardening cement is adopted or suitable accelerators are incorporated in the concrete mix; curing with steam or electric heating is also of value in regard to rapidity of hardening.

For most of the design calculations, Dr. Thomas pointed out, no new theory is necessary. The classic theory of elasticity is applicable if approximate allowances are made for the effects of inelastic deformations due to creep (of steel and concrete) and to shrinkage of the concrete. There are two main systems of pre-stressing: the pre-tensioning system, in which the wires are stretched before the concrete has set; and the post-tensioning system, in which the wires are stretched after the concrete has hardened and obtained considerable strength. Whatever basic system of pre-stressing is adopted, there are many variations in the actual detailed arrangements. A study of the relative merits of the main processes has led Dr. Thomas to the conclusion that there is no general technical justification for one rather than another; the method to be chosen appears to depend upon technical and economic considerations relating to the particular circumstances of each design.

Referring to constructional work already completed, Dr. Thomas observed that the main advantages of pre-stressing have been obtained in beams and fluid-retaining structures. In the case of beams, the greatest advantages are reached where the effects of reduced sections and light weight are particularly important, that is, in bridges of larger span. In the case of fluid-retaining structures, where cracking must be avoided and where difficulty has been experienced in obtaining satisfactory joints in ordinary reinforced concrete, it seems certain that in the future a greater proportion of these structures will be made of pre-stressed concrete.

The possibility of using pre-stressing for roads or runways is of interest, particularly in view of the difficulty experienced in the past in obtaining good joints. In the Orly Airport runway, Freyssinet has experimented in this direction, and it may well be that pre-stressing will solve another difficult civil-engineering problem.

In the discussion which followed the presentation of the introductory paper, several speakers emphasized the desirability of using high-grade materials. Mr. J. W. H. King (Queen Mary College, London) pointed out that metallurgical study shows that the hard-drawn wire commonly used for pre-stressing possesses certain properties as a result of the drawing process in manufacture (for example, creep under sustained load or deformation) which are detrimental to the efficiency of the wire as a pre-stressing agent, subject to high tensile stress for the whole life of the structure. Prof. R. H. Evans (University of Leeds) agreed with Dr. Thomas that with 0·2-in. diameter wire the margin of safety against wire slip, in systems dependent on the bond between concrete and steel, is often not sufficient. Tests at the University of Leeds have shown that, for the transfer of the pre-stressing load from the steel to concrete by surface interaction alone, a length of wire of 80–250 diameters is necessary. Triple-stranded wires have been found to have better bond characteristics than single round wires. Mr. U. Bjuggren (Stockholm) remarked that in Sweden small-diameter (0·08-in.) wires are used in pre-tensioning systems; up to 140 wires have been used in a relatively small cross-section, and satisfactory bond has been obtained.

In regard to the concrete quality, Dr. A. R. Collins (Cement and Concrete Association) spoke of the simplicity of the arrangement of steel in pre-stressed concrete, contrasting this with the conglomeration of reinforcement in ordinary reinforced concrete. The simplicity is coupled with a greatly reduced amount of steel and allows the use of a concrete of relatively low workability and high durability. Concrete of high strength is not difficult to obtain if adequate control is exercised in the measurement and proportioning of the materials, and if the water content is limited to the minimum necessary for proper compaction of the concrete.

Mr. R. S. V. Barber (Dow-Mac (Products), Ltd.) and Mr. J. Ludlow (Metropolitan-Vickers Electrical Co., Ltd.) described work on electric heating as a method of accelerating the hardening of concrete, pointing out that electric heating can be arranged with the electric current passing through the concrete or alternatively through the reinforcing wires. The former has been used as a conductor, particularly in the U.S.S.R., to avoid frost action during the early hardening of the concrete, but a high current-density may affect the proper hydration of the cement. Mr. Barber and Mr. Ludlow said that they have therefore used the alternative method, namely, of heating the embedded wires, in the production of concrete railway-sleepers. This method has the advantages that the electrical resistance of the steel is constant, stable and small. The arrangement of straight wires in the pre-tensioning system is ideal for this treatment, which has resulted in a reduction in the production cycle from five to one day or even less.

On the fundamental approach to the design of pre-stressed concrete members there was some divergence of opinion. Prof. A. L. L. Baker (University of London) presented an analytical method for the determination of the ultimate strength of a pre-stressed concrete beam, and Prof. A. D. Ross (University of London) discussed the accurate assessment of losses of pre-stress due to inelastic deformation of the concrete. Other speakers were in favour of simple approximations for these losses; and Mr. Bjuggren (Stockholm) relied for his designs on empirical rules based on hundreds of tests.

The application of pre-stressed concrete to various structural systems was discussed by several speakers. Major A. J. Harris (Société Technique pour l'Utilisation de la Précontrainte, Paris), representing M. E. Freyssinet, showed how the difficulties of obtaining structurally continuous systems have been overcome in France. In statically indeterminate systems, pre-stressing tends to modify the supporting reactions for beams, involving an elaboration of the design calculations, and it also introduces practical difficulties. M. Freyssinet has devised a system of beams of variable cross-section, pre-stressed by straight cables, which has largely obviated the difficulties. In an alternative solution, the reactions are adjusted in practice to the values assumed in design, by introducing special small flat jacks. Major Harris also described the construction of bridges from pre-fabricated units. Elements 6 ft. long, cast in a factory, are later assembled to form a 240-ft. span bridge, the elements being held together by pre-stressing cables.

Mr. N. W. Swinnerton (British Railways) described the development of pre-stressed concrete railway-sleepers in Great Britain, involving laboratory tests and trials in high-speed track, leading to two designs which show promise. Mr. J. S. Campbell and Dr. P. W. Abeles (British Railways) spoke of successful bridge construction already completed in Great Britain and of further work soon to be started. In this latter connexion, Dr. Abeles discussed designs in which pre-stressed units would be combined with *in situ* concrete without preliminary stress, and gave details of tests showing that such composite construction is practicable and amenable to accurate stress analysis.

Mr. L. W. Elliott put forward the architect's point of view on pre-stressed concrete. The three essential considerations are the æsthetic, the functional and the economic aspects. The practical examples have shown that æsthetic and functional requirements can be well satisfied, and it appears that this type of construction is also economical. Mr. D. H. May (Stressed Concrete Design, Ltd.) discussed the economical aspect further, and gave evidence of cases in which pre-stressed concrete has been chosen, in direct competition with steel and reinforced concrete, for several structures in Europe and in America.

The proceedings of the conference are to be published later this year.

NEW FELLOWS OF THE ROYAL SOCIETY

AT the meeting of the Royal Society on March 17, the following were elected to fellowship:

Prof. J. F. Allen, professor of natural philosophy, University of St. Andrews, distinguished for his work in low-temperature physics, especially for his discovery of new phenomena shown by liquid helium.

R. W. Bailey, head of the Mechanical and Metallurgical Research Department at Metropolitan-Vickers, Manchester, distinguished for contributions on the behaviour of metals at high temperatures and for advances in design of turbines.

Dr. F. C. Bawden, head of the Plant Pathology Department at Rothamsted Experimental Station, Harpenden, distinguished for his work on plant viruses and virus diseases, and for important contributions to the study of virus serology.

Prof. F. W. Rogers Brambell, Lloyd Roberts professor of zoology, University College of North Wales, Bangor, distinguished for his experimental studies of processes of reproduction in mammals and of the factors concerned in antenatal mortality.

Prof. K. E. Bullen, professor of applied mathematics in the University of Sydney, distinguished for work in geophysics, particularly in relation to earthquakes and the distribution of density within the earth.

Dr. E. B. Chain, university demonstrator in chemical pathology, University of Oxford, distinguished for his work on enzymes of snake-venom and bacteria, and especially for his researches on penicillin and other antibiotics.

Dr. U. R. Evans, reader in metallic corrosion, University of Cambridge, distinguished for his researches on metallic corrosion.

Prof. E. D. Hughes, professor of chemistry, University College, London, distinguished for his researches in the mechanism of the reactions of carbon compounds.

Prof. W. Q. Kennedy, professor of geology, University of Leeds, distinguished for his contributions to tectonic geology and petrogenesis.

Prof. W. B. R. King, Woodwardian professor of geology, University of Cambridge, distinguished for his researches on the Lower Palæozoic rocks and on Pleistocene deposits.

Sir Ben Lockspeiser, chief scientist, Ministry of Supply, distinguished for his contributions to the development of modern aircraft.

Dr. J. M. McNeill, naval architect, John Brown and Co., Ltd., Clydebank, distinguished for his contributions to naval architecture.

Dr. H. R. Marston, chief of the Division of Biochemistry and General Nutrition, Commonwealth Council for Scientific and Industrial Research (University of Adelaide, South Australia), distinguished for his researches on nutrition and wool-growth in merino sheep and on trace element-deficiency diseases in ruminants.

Prof. K. Mather, professor of genetics, University of Birmingham, distinguished for his contributions to genetics and particularly for his studies of polygenic inheritance.

Prof. P. B. Medawar, Mason professor of zoology and comparative anatomy, University of Birmingham, distinguished for his studies of growth processes and the phenomena associated with tissue transplantation

Dr. W. T. J. Morgan, research worker, Lister Institute of Preventive Medicine and reader in biochemistry in the University of London, distinguished for his contributions to the chemistry of immunology and blood groups.

N. W. Pirie, head of the Biochemical Department, Rothamsted Experimental Station, Harpenden, distinguished for his researches on the chemical and physical properties of plant viruses.

Prof. C. F. Powell, Melville Wills professor of physics, University of Bristol, distinguished for his contributions to experimental physics, especially for his work on the properties of mesons.

Dr. D. A. Scott, research member, Connaught Laboratories, University of Toronto, distinguished for his contributions to the chemistry of insulin, heparin and carbonic anhydrase.

Prof. Wilson Smith, professor of bacteriology, University College Hospital Medical School, London, distinguished for his researches on the virus of influenza and on the pathology of staphylococcal infections.

Dr. G. B. B. M. Sutherland, reader in spectroscopy, Department of Colloid Science, University of Cambridge, distinguished for his experimental researches on infra-red and Raman spectroscopy, especially of hydrocarbons.

Prof. O. G. Sutton, professor of mathematics and physics, Military College of Science, Shrivenham, distinguished for his researches in atmospheric turbulence and evaporation.

Prof. Meirion Thomas, professor of botany at King's College, Newcastle-upon-Tyne, distinguished for his researches in plant physiology, and particularly for his work on the breakdown of sugar in the plant.

Prof. J. M. Whittaker, professor of mathematics, University of Liverpool, distinguished for his researches in the theory of integral functions.

Prof. F. G. Young, professor of biochemistry, University College, London, distinguished for his studies of the role of the hormones of the anterior lobe of the pituitary gland in carbohydrate metabolism.

NEWS and VIEWS

King's College, London: Prof. W. T. Gordon

PROF. W. T. Gordon retires at the end of the present session from the chair of geology, King's College, London. He joined the staff of the College as lecturer in charge of the then quite small Department of Geology in 1914. In 1921 he became professor of geology, a post held in the earlier days of the College by Charles Lyell, John Phillips, D. T. Ansted, James Tennant and Martin Duncan. It fell to Gordon to organise the expansion of the Department and its work which followed the First World War, and he also served as administrative head of the Department of Geography conducted jointly with the London School of Economics. Throughout his long years of service, Prof. Gordon has been a well-known and well-loved figure in his College and his University, taking a large part in the life and work of both. At the same time he has continued to prosecute his researches into the Scottish Lower Carboniferous flora, begun as a young man in Edinburgh. Not the least of his great services to his College arose from his abiding interest in mineralogy: the Department possesses by virtue of his efforts an unusually fine collection of well-crystallized minerals, and his own collection of gem stones has become justly famous to a long succession of students.

Dr. J. H. Taylor

DR. J. H. TAYLOR, who succeeds Prof. Gordon as professor of geology at King's College, London, in September, was educated at Clifton College, Bristol, and was an undergraduate at King's College. As such, he distinguished himself in every field, in scholarship, athletics and general service to the College. He obtained first-class honours in geology at the Final Examinations of the University of London, and, as the most distinguished man of his year in science at King's College, he was awarded the Jelf Medal, the most prized distinction to which a student can aspire. After a year's service on the staff of the Geological Department at King's College, he was elected to a Henry Fellowship at Harvard University, and while there he obtained the degree of A.M. Returning to Britain to join the Geological Survey of Great Britain, he continued his petrological researches into the rocks of the East Midlands, and particularly the sedimentary iron ores and associated rocks of Northamptonshire and Leicestershire. He was, consequently, selected as a member of the party asked to study and report upon the mining methods in Germany used to work the Cretaceous iron ores of the Salzgitter-Ilsede region, and the Dogger ores of Bavaria, Württemberg and Baden. While a member of the Geological Survey, Dr. Taylor continued lecturing work at the Working Men's College, Crowndale Road, London, and has been a member of Council of that College for many years. It will be clear from these varied activities that Dr. Taylor is a man of personality and drive. He has had a wide experience in geological work in the class-room and in the field in Britain, America and on the Continent, and will bring a highly trained, versatile and well-balanced mind to the problems of university education in geology.

Engineering at the University of Leeds: Prof. D. G. Christopherson, O.B.E.

DR. D. G. CHRISTOPHERSON, whose appointment as professor of mechanical engineering at the University of Leeds, in succession to the late Prof. W. T. David, has been announced, was educated at Sherborne School and University College, Oxford, where he took first-class honours in engineering science in 1937. He held a Henry Fellowship at Harvard University during 1938–39, and was for several years a member of Sir Richard Southwell's research team developing 'relaxation methods'. He was part author of the first paper in which the application of these methods to partial differential equations was presented, and his thesis for the Ph.D. degree in 1941 dealt entirely with this important branch of the work. During the period 1941–45, he was a member of the scientific staff of the Research and Experiments Department, Ministry of Home Security, and was made an O.B.E. in 1945. Dr. Christopherson was appointed a University demonstrator in the Department of Engineering, Cambridge, in April 1945, and was elected a Fellow of Magdalene College. In 1946 he was promoted to lecturer and in 1947 he became bursar of Magdalene. Though Christopherson has contributed papers on vibrations and structural problems, his interests lie mainly in the region of applied mechanics, and particularly in the theory of lubrication.

Holweck Prize and Medal: Prof. L. F. Bates

DR. L. F. BATES, Lancashire-Spencer professor of physics in the University of Nottingham, has been awarded the Holweck Prize and Medal by the Société Française de Physique. The Holweck Prize was founded by the Physical Society as a memorial to Fernand Holweck, director of the Curie Laboratory of the Radium Institute in Paris, and to other French physicists who were killed by the Germans during the occupation. The Société Française de Physique founded the Holweck Medal in bronze for presentation to the prizewinner. The award is made annually, alternately to a French and to a British physicist, for distinguished work in experimental physics. Prof. Bates is a leading authority on experimental magnetism. His book "Modern Magnetism", which appeared in 1939, has achieved an international reputation, and a second revised and enlarged edition appeared last year. His original work in an experimental field known for its difficulty is distinguished by a technique which he has built up since 1924 entirely by independent effort. In particular, his work on the heat liberated in step-by-step magnetism in the hysteresis cycle has advanced knowledge in a field where progress has long been retarded by the experimental difficulties. His work on the changes of specific heat at the ferromagnetic Curie point and his investigations of other properties of ferromagnetic substances are outstanding. His investigations in magnetism constitute a solid body of successful achievement which commands attention and admiration both at home and abroad. Magnetism is a subject in which there is now much interest in France, as instanced by the work of Néel and his school, and Prof. Bates will be warmly welcomed when he delivers his lecture in Paris in the early summer.

University of Birmingham and the Midland Region

AMONG other topics dealt with by the Vice-Chancellor of the University of Birmingham (Sir Raymond Priestley) in his report to the Court of Governors is that of the cordial relations between the University and the Midland region. During the period 1935–47 the University received £1,450,000 in benefactions, excluding further promises under seven-year covenants of about £700,000, a fine record for its friends and supporters; and in this respect it surpasses all universities except Oxford. Local government grants, too, have substantially increased, facts which are regarded by the Vice-Chancellor as a recognition of success and a token of confidence. A significant development has been the establishment of the Midland Advisory Council on Industrial Productivity, "an attempt to gear the new development in Engineering Production (made possible by the generous benefaction of Messrs. Joseph Lucas, Ltd.) to the regional productive drive". The Lucas chair in the principles of engineering production, of which Prof. T. U. Matthew is the first occupant, has as its object postgraduate teaching and research on engineering production and the principles of industrial management. This Advisory Council is intended to promote closer liaison between Midland industries and the University of Birmingham in order to improve standards of productivity. A further expression of the support of industry is the generous provision by Tube Investments, Ltd., of £1,500 per annum for seven years for the establishment of a research fellowship in engineering production. The first holder of this fellowship is Mr. Mansergh Shaw, senior lecturer in engineering in the University of Melbourne. To assist Prof. Matthew in developing the postgraduate courses, Mr. P. B. R. Gibson has been appointed as lecturer, and lectures in engineering economics for final-year mechanical and electrical engineering students have been arranged as introductory to the postgraduate courses. It is expected that postgraduate students will be, in the main, sent by industrial firms; they will be expected to have had considerable industrial experience and to possess the attributes essential for success in management.

Philosophical Society of the Sudan

A NATION is judged not only by its resources and productivity but also by its standard of scholarship and culture; and an indication of this may be estimated by its number and quality of learned societies. In company with the present-day awakening throughout Africa, the Sudan is, and has been, making great progress in the field of economic development and towards a larger measure of self-government. It is pleasant to report that learning is keeping pace with this development, and that the Philosophical Society of the Sudan, which was founded on February 2, 1946, is flourishing and setting a high standard. The *Proceedings* for 1946–47 record the activities of this Society for the first year of its existence. At the inaugural meeting seventy-five founder members were enrolled, and the officers and committee were elected. Soon after, at the first ordinary meeting, the president, Mr. A. J. Arkell, gave his address. After discoursing on archæological discoveries in the district, he went on to stress the wide possibilities of local research in the various fields of archæology, geology and geography for piecing together the history of the Sudan, and also the need for research on modern aspects of Sudanese life, such as local industries and crafts, place-names, languages, customs, etc. Finally, there was the necessity for an adequate museum and library to consolidate and display the results of such research.

This presidential address seems to have been taken up by the members of the Society, for, during the year, papers were presented dealing specifically with the Sudan on the following subjects: archæological finds in local caves; manuscripts relating to the early Muslim period; distribution of types of soil and discoveries of fossils; relation between soils and local vegetation; Turkish administration during 1823–37; agricultural research; history during 800 B.C.—A.D. 350; and archæological finds (this last being another address by the president). Other papers which were of rather more general interest included such topics as transport, light reading in the Middle Ages, welfare and development, examinations, rates of evolution, and forestry. The Society is to be congratulated on a successful year and on its increase of membership to more than a hundred. The officers for 1948–49 are: *President*, Dr. J. Smith; *Vice-President*, G. W. Ogden; *Honorary Secretary*, A. W. Ireland; *Assistant Honorary Secretary*, L. S. Cobley; *Honorary Treasurer*, G. C. Wood. The address is the Secretary's Office, c/o General Post Office, Khartoum.

Limiting Factors in World Development

In his address, "Limiting Factors in World Development, or What is Possible", to the Associated Scientific and Technical Societies of South Africa at Johannesburg on August 11, 1948, Sir Harold Hartley suggested that a primary cause of our present troubles is the failure to realize that in the twentieth century, with the exploitation of the virgin lands, the slowing down of the growth of population and the disappearance of 'easy money', a new technique is required to give a dynamic impulse to international trade and stimulate both production and purchasing power. The future depends on increasing both production and purchasing power, and Sir Harold then examined more particularly the limiting factors in agricultural production. Of these, water comes first, and he stressed the importance of irrigation, draining and soil conservation. Climate comes next, and here we have the problem how far science can overcome the handicap of temperature extremes by improved living conditions, diet and clothing. Soil presents a very intricate and difficult scientific problem; but great advances are being made, although we are only now realizing the delicate balance in the top few inches of soil on which fertility depends. Next comes man-power and human skill, involving questions of education, physique and incentives if production is to be improved. Diseases and pests have been a major limiting factor; but here we have immediate reason for optimism in recent discoveries and developments both for protecting the individual and for the eradication of carriers of disease and destruction of pests themselves.

Transport is another determining factor by making possible the exchange of commodities and the movement of individuals, and Sir Harold stressed the value of air transport in opening up undeveloped regions. This factor is intimately linked with the economic factor of energy and power and the corollaries of equipment and capital, and in this connexion he said there must be a growing emphasis on the processing of farm and forest products; this is a great new field for the agriculturist and the chemical engineer. Finally, an orderly solution of the problems of production in any area depends on a survey of its natural resources, human geography, economic structure and capacity for production and consumption. The technique of making such surveys is in its infancy, and Sir Harold stressed the contribution of the aeroplane and of wireless. Moreover, the value of such national surveys would be enhanced by some clearing house through which the results could be made available for all countries. In human engineering, however, man is the limiting factor, and we are fighting once more for the freedom and ethical standards of Western civilization. Nevertheless, men with vision and imagination, with the power to foresee what modern methods can achieve, with confidence in the future and with human interest in the backward peoples and determination to improve their lot, will be the pathfinders in the quest of plenty.

National Research Council (Canada): Review of 1948

The "National Research Council Review, 1948" (N.R.C. No. 1713. Pp. 216. Ottawa: King's Printer, 1948. 75 cents) describes the work of the Council during the year ended December 31, 1947, and gives more detailed information regarding the work of the laboratories than is contained in the annual report, the last (thirty-first) of which covered the year ended March 31, 1948 (see *Nature*, November 6, p. 748). Besides the more specific accounts of work in progress, the Review includes a full list of scientific staff, arranged by Divisions, now totalling 2,682 persons, with details of the representation of the National Research Council on outside committees. In addition to statistics of scholarships and fellowships awarded in 1947–48 and their distribution, there is an analysis of those awarded during 1917–48. Reports from the various Associate Committees list the members of those Committees, while the value of the reports from the Divisions of Atomic Energy Research, Applied Biology, Chemistry, Applied Chemistry, Mechanical Engineering, and Radio and Electrical Engineering is enhanced by the inclusion of lists of publications of the Divisions during the year. The Review is thus a most useful annual reference work on the work of the Council. Reference has already been made (*loc. cit.*) to features of the work of the Council during the year. It can only be added here that besides giving a clear picture of the organisation and activities of the Atomic Energy Research Division, the Review refers to a development unnoticed in the annual report—the establishment of a new company, Canadian Patents and Developments, Ltd., with a board of directors of representatives from industry, the universities and the National Research Council. The primary purpose of this Company is to make available to industry through licensing arrangements the inventions, new processes and improvements in processes, developed by the scientific workers of the Council. It is anticipated that the Company will eventually have charge of all Government-owned patents which can be made available to industry, including some 1,300 enemy patents now held by the Custodian of Enemy Property. The Company is also intended to provide a channel for the flow to industry of new developments by scientific workers in the universities.

Ancient Pottery of the Near East

POTTERY sherds, when they occur, are some of the most useful 'fossils' the prehistorian can have to deal with. When they are found with an industry, one can be almost certain that they are contemporary. It follows, then, that a known ware imported from some distant region and found associated with an unknown industry will date that industry with reasonable accuracy as being contemporary with the culture which manufactured the particular ware in question. This is not so true in the case of beads. It is a fact, of course, that when the association is real and there has been no subsequent chance introduction, the industry with which the bead of known date is found must be either contemporary with it or later in date. But beads have a long survival value; necklaces made of Egyptian beads were popular in late Victorian times, thousands of years after they were made. Prehistoric housewives, however, smashed crockery as freely as their descendants, and the survival value of a pottery vessel in use is limited. Pottery, then, is particularly useful for correlating in time various cultural levels from different regions. We can therefore be grateful to Marian Welker, who in a paper entitled "The Painted Pottery of the Near East in the Second Millenium B.C. and its Chronological Background", has brought together in convenient form a wealth of detail of the pottery in the Near East at this period (*Trans. Amer. Phil. Soc.*, N.S., **38**, part 2; September 1948). The paper is arranged by sites and areas, considering especially a number of Syrian localities. The author considers that Mesopotamian influence on the development of the wares in these sites is sporadic and that we shall have to look rather to an Iranian cradle for their origin. Chronological tables and some pages of illustrations are included, and the resulting volume will certainly prove of great use to students. There are also a catalogue of forms and several pages of references.

Society of Public Analysts and Other Analytical Chemists

THE seventy-fifth annual general meeting of the Society was held on March 9 in the meeting room of the Royal Society, Burlington House, London, W.1, with the retiring president, Mr. Lewis Eynon, in the chair. In his address, Mr. Eynon began by remarking on the Society's membership of 1,500, a doubling of the figure of ten years ago; he announced that, in alternate years in which no change of president occurs, the lecture which is delivered at the annual general meeting will in future be known as the Bernard Dyer Memorial Lecture, in honour of the late Dr. Bernard Dyer. The main theme of Mr. Eynon's address was the fundamental importance of analysis to the progress of chemistry and the necessity for giving a prominent place to analysis in the training of the student of chemistry. He said that although two former presidents of the Society had both deplored the inadequacy of training in analytical chemistry, little advance has been made in the status of analysis as a subject of instruction in the universities and technical colleges of Great Britain; indeed, the position has if anything become worse owing to the increasing claims of other branches of the science on a student's time. The great utilitarian value of training in analysis is too obvious and manifold when one considers its application to industry, medicine, water supply and Government inspection. The most important practicable step is for the establishment of chairs of analytical chemistry in universities and colleges and for a longer period of training for the student. With the present unsatisfactory conditions of training there is a serious danger that within the next twenty years the analyst himself will be "weighed in the balance and found wanting".

The following officers and members of Council were elected for the ensuing year: *President*, George Taylor; *Past Presidents serving on the Council*, F. W. F. Arnaud, Lewis Eynon, E. B. Hughes, G. Roche Lynch, S. E. Melling, G. W. Monier-Williams; *Vice-Presidents*, C. A. Adams, H. E. Cox, J. R. Nicholls, J. G. Sherratt (chairman, North of England Section), J. Sword (chairman, Scottish Section); *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, K. A. Williams; *Other Members of Council*, N. L. Allport, R. C. Chirnside, J. F. Clark, D. C. Garratt, J. G. A. Griffiths, E. T. Illing, J. King, J. E. Page, C. J. Regan, F. A. Robinson, N. Strafford, A. M. Ward, A. Lees (honorary secretary, North of England Section), R. S. Watson (honorary secretary, Scottish Section).

New Grassland Research Station at Hurley, Berks

A NEW Grassland Research Station for Great Britain is being established by the Minister of Agriculture and the Secretary of State for Scotland in co-operation with the Agricultural Research Council. The new Station will occupy an area of 500 acres at Hurley, Berkshire, adjoining the new Berkshire Farm Institute. Its work will be the investigation of problems relating to the sward and its production and maintenance under different conditions, but mainly under those of medium and low rainfall. The existing Grassland Improvement Station at Drayton, Stratford-on-Avon, will be transferred to and amalgamated with the new Station. The work at Hurley will be carried out in close co-operation with that of the Welsh Plant Breeding Station at Aberystwyth, the Scottish Society for Research in Plant Breeding and other research institutions, and it will be under the scientific supervision of the Agricultural Research Council. The Station will be controlled by a Governing Body which will be constituted as a company limited by guarantee and without share capital, grant-aid being given by the Ministry of Agriculture. The thirteen members who have been appointed to the Governing Body, and of which Prof. H. G. Sanders is chairman, provide a balanced representation of scientific knowledge and practical farming experience.

Liquid Helium-3

IN the *Physical Review* of January 15, p. 303, S. G. Sydoriak, E. R. Grilly and E. F. Hamel report that on October 13, 1948, they succeeded in condensing pure helium-3. This is especially interesting, since several physicists, F. London, Tisza, and others, have expressed doubts that helium-3 would liquefy. Twenty c.c. (measured at S.T.P.) of helium-3 were used, and condensation took place at the bottom of a 1·2-mm. bore stainless steel capillary immersed at a depth of 5–10 mm. in the liquid helium well. Condensation was assumed to be taking place when the equilibrium pressure in the capillary was independent of the volume of helium which remained in the mercury manometer connected to the room-temperature end of the capillary. From the data obtained, $3{\cdot}3_4$° K. was chosen as the critical temperature of helium-3. The vapour pressure measurements showed that at 1·2° K. the vapour pressure of helium-3 was thirty-five times that of helium-4; helium-3 was suitable for thermometry at low temperatures down to 0·5° K. and perhaps lower; the normal boiling point of helium-3 was 3·2° K., and by extrapolation to the critical temperature the critical pressure was 875 mm. of mercury. A value of 0·041 gm./c.c. for the critical density was deduced.

Birds in London

In April 1947 the Minister of Works appointed a Committee on Bird Sanctuaries in the Royal Parks (England and Wales). For its general objectives the Committee decided to: (1) make suggestions for increasing the resident population of birds, their number and variety; (2) make suggestions for attracting migratory birds and for inducing unusual visitors to stay longer; (3) select competent persons as observers and reporters.

The Committee has now reported, and the results of its deliberations have been set out in a pamphlet, "Birds in London" (H.M. Stationery Office. *9d.*). The first duty was the appointment and guidance of competent observers, and it is their statements which provide most of the material in the pamphlet. They show how successful has been the policy of developing the London bird sanctuaries, which were originally set up so long ago as 1923.

Young Children

To mark the year of its silver jubilee, the Nursery School Association of Great Britain has begun the publication of a new quarterly journal. This follows the formation of the World Council of Early Childhood Education after an international meeting in Prague in August 1948, and the new journal is intended to act as a link between all who are interested in the education of young children in any part of the world. Volume I of *Young Children* contains articles on the use of water play in the nursery, the stages of education which follow the nursery school and the links between home and school. The new journal has been produced unpretensively and should strengthen a side of education which has been much neglected by existing journals. It is doubtful, however, if the new journal will survive unless the price is reduced.

Hundredth Meeting of the Genetical Society

The Genetical Society of Great Britain, founded in 1919 by William Bateson, will hold its hundredth meeting during June 30–July 1, in Cambridge. To mark the occasion guest speakers will review the early days of genetics, and there will also be comprehensive demonstrations of genetical work now in progress in Great Britain. Genetical societies abroad have been informed of this meeting, to which all geneticists are cordially invited. Details may be obtained from the secretaries, G. Pontecorvo, Department of Genetics, University, Glasgow, W.2, or H. G. Callan, Institute of Animal Genetics, University, Edinburgh 9.

The Night Sky in April

Full moon occurs on April 13d. 04h. 08m., u.t., and new moon on April 28d. 08h. 02m. The following conjunctions with the moon take place: April 9d. 13h., Saturn 3° S.; April 20d. 03h., Jupiter 5° N.; April 29d. 21h., Mercury 0·7° S. Mercury is in superior conjunction on April 13 and is not favourably placed for observation until later in the month; the planet sets 1h. 45m. after the sun on April 30, and can be seen in the western sky. Venus, in superior conjunction on April 16, is too close to the sun for favourable observation throughout the month. Mars rises about the same time as the sun during April, and cannot be observed. Jupiter is a morning star, rising at 3h. 20m., 2h. 30m. and 1h. 35m., at the beginning, middle and end of the month, respectively, and can be seen low down for a few hours before sunrise. Saturn sets in the early morning hours and is visible throughout the greater part of the night. Occultations of stars brighter than magnitude 6 are as follows: April 1d. 19h. 46 3m., 45 Arie. (*D*); April 7d. 00h. 31·4m., *c* Gemi. (*D*); April 11d. 20h. 56·3m., η Virg. (*D*). *D* refers to disappearance, and the latitude of Greenwich is assumed. The Lyrid meteor shower is active about April 18–24. A total eclipse of the moon, visible at Greenwich, takes place on April 13, the circumstances of which are given as follows: moon enters penumbra, 01h. 31·6m.; enters umbra, 02h. 27·7m.; total eclipse begins, 03h. 28·0m.; middle of eclipse, 04h. 10·9m.; total eclipse ends, 04h. 53·8m.; moon leaves umbra, 05h. 54·1m.; leaves penumbra, 06h. 50·3m. A partial eclipse of the sun, visible at Greenwich, occurs on April 28, its magnitude being 0·41 at Greenwich, where it begins at 6h. 21m., reaches its greatest phase at 7h. 15m., and ends at 8h. 14m.

Announcements

On the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1948 to Sir Edward Appleton. The medal is awarded annually, and was founded in 1936 in memory of Sir Alfred Ewing. This award has come appropriately when Sir Edward has just taken up his appointment as vice-chancellor of the University of Edinburgh, a position which Sir Alfred Ewing occupied with such distinction.

Dr. R. P. Linstead, director of the Chemical Research Laboratory, Teddington, since 1945, has accepted the invitation of the University of London to succeed Sir Ian Heilbron as professor of organic chemistry and director of the Organic Chemistry Laboratories at the Imperial College of Science and Technology as from April 1, or as soon afterwards as can be arranged.

M. Gaston Dupouy has been elected *correspondant* for the Section of General Physics of the Paris Academy of Sciences in succession to Prof. W. J. de Haas, who has been elected a foreign associate.

A division of the Royal Aeronautical Society has recently been formed in South Africa on the same lines as those formed in Australia and New Zealand in October 1948. Associate fellows will still be elected by the parent body of the Society in London; but otherwise these Divisions of the Commonwealth will possess a fully self-governing status and will be free to develop along their own national lines.

The Royal Photographic Society will be holding its annual exhibition at 16 Princes Gate, London, S.W.7, in two parts: part 1 (pictorial and colour), September 9–October 2; part 2 (scientific, Nature, medical, record, press, commercial, industrial, technical and radiographic), October 8–26. Admission will be free. Entries must be received by July 23, and entry forms may be obtained from the Secretary at the above address.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Analgesic Drug Analogous to *iso*Amidone

IN the course of our search for new analgesics free from undesirable side-effects, 6-piperidino-4 : 4-diphenyl-5-methyl-3-hexanone (III) (the piperidyl analogue of *iso*amidone) has been synthesized by the following route :

$$Ph_2CH.CN + ClCHMe.CH_2NC_5H_{10} \rightarrow$$
$$\text{(I)}$$
$$Ph_2C(CN).CHMe.CH_2NC_5H_{10} \rightarrow$$
$$\text{(II) (HCl, m.p. 225–226°)}$$
$$Ph_2C(CEt : NH).CHMe.CH_2NC_5H_{10} \rightarrow$$
$$\text{(2HCl, m.p. 193°)}$$
$$Ph_2C(COEt).CHMe.CH_2NC_5H_{10}$$
$$\text{(III) (HCl, m.p. 197–198°)}$$
$$\text{(HBr, m.p. 208–209°)}$$

In the combined synthesis of amidone and *iso*amidone it has been shown that at least two isomeric nitriles are formed by the condensation of diphenylacetonitrile (I) and 1 (or 2)-chloro-2-(or 1)-dimethylaminopropane, owing to ring formation in the latter[1], and in view of the isolation of a third isomer of amidone[2] other chemical mechanisms may also operate. As the synthesis shown in the above scheme does not, therefore, establish the structure of the product, this was elucidated by the process of exhaustive methylation on the penultimate nitrile (II) on lines similar to those described by Schultz, Robb and Sprague[3].

Degradation of the nitrile (II) gave *N*-methylpiperidine (picrate, m.p. 222° [4]) and 2 : 2-diphenyl-3-methylbutenenitrile, m.p. 64–65°, apparently identical with that obtained by the American workers[3]. On hydrogenation it gave 2 : 2-diphenyl-3-methyl-*n*-butylamine, of which the phenyl urea derivative, m.p. 204–205°, was identical with a specimen synthesized by an independent method. Work is now proceeding with the view of isolating any other isomer of (III) that may be formed.

The piperidyl analogue of *iso*amidone has proved of considerable pharmacological interest, since it shows the smallest degree of undesirable side-actions of any of the active analgesic drugs we have yet studied. The methods used for the assessment of toxicity, analgesic and respiratory depressant activities have been described[5,6], and the results obtained with this compound are shown in the accompanying table, together with the figures previously reported for amidone and *iso*amidone. In all cases morphine has been used as the standard for the measurement of analgesic and respiratory depressant actions.

'Piperidyl *iso*amidone' (III) shows the same effects in acute animal toxicity experiments as amidone or *iso*amidone, death in all cases resulting from acute cardiac failure. All these compounds differ from morphine in this respect, since they are many times more toxic upon rapid intravenous injection than is morphine, although the toxicities in sub-acute experiments are very much more similar to that of morphine. All the compounds referred to, with the exception of morphine, are toxic to the isolated rabbit heart (Langendorff's preparation) at concentrations stronger than 1 part in 100,000, although 'piperidyl *iso*amidone' alone shows appreciable coronary dilator activity in concentrations below this figure.

Compound	Toxicity (I.V. mice) mgm./kgm.	Analgesic activity		Respiratory depressant activity	
		Equi-active doses mgm./kgm.	Approximate ratio	Equi-active doses mgm./kgm.	Approximate ratio
Morphine	—	3·0	1·0	4–5	1·0
Amidone	12·5–25*	2·2–2·5	1·3	2·5	1·4–2·0
*iso*Amidone	40	3·0	1·0	7–10	0·4–0·7
'Piperidyl *iso*amidone'	25	3·0	1·0	12	0·3–0·4

* The toxicity of amidone and its optical isomers in mice is greatly influenced by the strain of animals employed, the published figures showing very wide variations.

In man 'piperidyl *iso*amidone' in doses of 12·5 mgm. produced no appreciable side-actions. When the dose was increased to 25 mgm., some of the volunteers described a sensation of warmth, were flushed and slightly dizzy, although the symptoms were less pronounced than those we have observed with other analgesic drugs. This drug was without significant effect upon the cardio-vascular system.

The depressant effect of 'piperidyl *iso*amidone' upon the respiratory response in human subjects to the inhalation of 5 per cent carbon dioxide in oxygen was examined by Prescott, Thorp *et al.*[7], and shown to be far less than that produced by equivalent analgesic doses of morphine, pethidine, amidone, *iso*amidone or Hoechst compound 10582, and to be approximately one third that of morphine.

From the table it would appear that *iso*amidone itself should be a superior drug to amidone; but in a few patients given *iso*amidone it was found that the duration of analgesic action was too short for the drug to be of real value. On the other hand, 'piperidyl *iso*amidone' produced analgesia similar in duration to that of amidone, and has shown sufficient promise to warrant an extensive examination and clinical trials, particularly in obstetrics, and the results of this work will be reported elsewhere.

Note added, January 10. Recently a second nitrile hydrochloride, m.p. 199–200°, isomeric with the hydrochloride of (II), has been isolated and converted into the corresponding ethyl ketone (6-piperidino-4 : 4-diphenyl-3-heptanone, $Ph_2C(COEt).CH_2.CHMe.NC_5H_{10}$) (HCl, m.p. 118–120°). Preliminary results obtained by Dr. A. C. White and Mr. A. F. Green, using young rats, indicate that this ketone is approximately twice as active as morphine analgesically, yet only equal to it as a respiratory depressant.

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Sept. 29.

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Constitution and Properties of Laccase

IT was shown that laccase, which had been inactivated by cyanide under certain conditions, could be almost completely re-activated by cupric ions, whereas other metals were ineffective[1]. Further evidence will be presented here to show that copper is an essential constituent of this enzyme. Laccase was purified by the method of D. Bertrand[2,3]. At each successive stage of purification the enzyme activity was measured in the manner previously described[1], and copper and manganese were estimated by microchemical methods[4,5]. Manganese disappears after the first steps of purification; the copper content increases with the Q_{O_2} and remains proportional to activity in all fractions up to the purest preparation having Q_{O_2} 30,000 in presence of *para*phenylene diamine (Fig. 1).

In recent papers, D. Bertrand has described three important properties of laccase which will be re-examined here. It is claimed that the activity of this enzyme is much more sensitive than that of other enzymes to small variations of *p*H [6]. For example, with pyrogallol as substrate, the 'relative Q_{O_2}' is said to fall from 10,000 to 1,500 when the *p*H changes from 6·5 to 7·0. On repeating these experiments, I found that the sensitivity of laccase to *p*H variations is no greater than is generally the case with enzymes, and that optimum activity is observed at *p*H 7·4 with pyrogallol and at *p*H 7·0 with *para*-phenylene diamine (Fig. 2).

Furthermore, D. Bertrand found that laccase, like cytochrome oxidase, has the property of oxidizing cytochrome *c*[7,8] and cystein[9], and this led him to believe that the two enzymes are probably closely related. However, if laccase is added to reduced cytochrome *c* and the mixture shaken in air, no spectroscopic change occurs. The oxidation of cytochrome *c* has also been studied manometrically in the way described by D. Bertrand[7,8]. Thus the oxygen uptake at 20° C. of a system consisting of laccase and 10 mgm. hydroquinone in 3·3 ml. phosphate buffer, *p*H 7·1, was only increased by 5–7 per cent by the addition of 0·2 ml. of 1 per cent cytochrome *c*. Since, however, the quantity of cytochrome *c* used in such experiments is at least thirty times greater than the quantity of laccase (assuming that pure laccase has a Q_{O_2} of 20,000 in the oxidation of hydroquinone), the resulting increase in oxygen uptake is insignificant, and there is thus no indication that cytochrome *c* is oxidized by laccase.

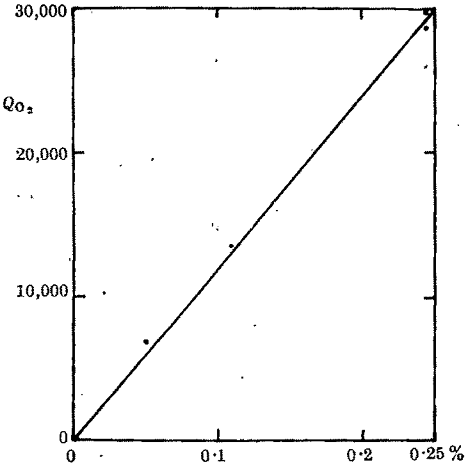

Fig. 1. Relation between the activity of the enzyme (Q_{O_2}) and the copper content

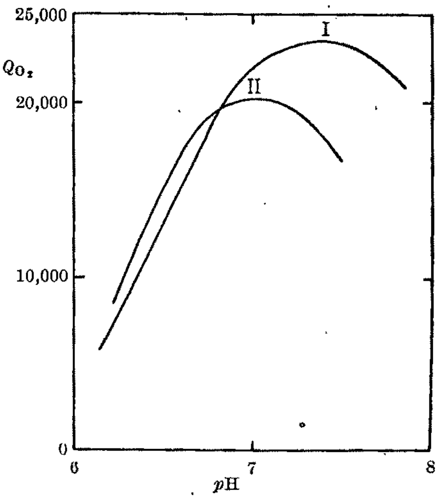

Fig. 2. *p*H curves of laccase activity. Curve I was obtained with pyrogallol and curve II with *para*phenylene diamine

The methyl ester of cystein, as well as cystein itself, is said to be oxidized by laccase[9]. It was claimed that this oxidation has the unusual feature that the *p*H activity curve shows two well-marked optima at *p*H 6·7 and 7·45, at which the rate of oxygen uptake is 31 and 27 per cent respectively of that by hydroquinone at *p*H 6·35. On repeating these experiments in Barcroft manometers, it was found that cystein was not oxidized at all by laccase, even after shaking for thirty minutes. The slow rate of oxygen uptake observed with laccase and cystein methyl ester represented only 5–8 per cent of that found with laccase and *para*phenylene diamine. Moreover, a study of the effect of *p*H on this slow oxidation revealed not two optima, but one at 7·1, and the *p*H activity curve was of the usual type. As laccase does not oxidize cystein, and as its effect on the methyl ester is very small, the conclusion that cystein can be oxidized directly by laccase is not justified.

A. TISSIÈRES

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Investigations with Radioactive Penicillin

MUCH of the published data regarding the mode of action of penicillin is necessarily concerned with secondary effects on bacteria, for example, rate of killing under different conditions, morphological changes, etc. By use of radioactive penicillin, it should be possible to find out directly something of the nature of the primary reaction between penicillin and the cell.

In a previous communication[1], we have described attempts to measure the amount of penicillin involved in the killing of bacteria, which gave no positive

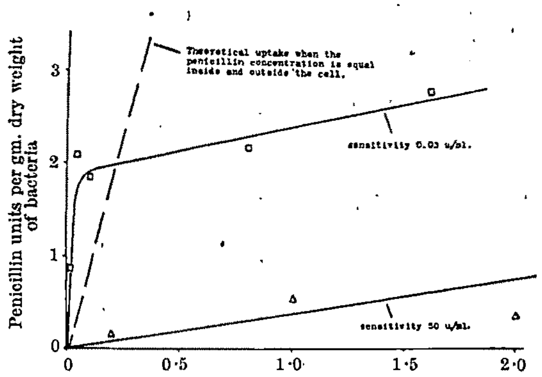

Fig. 1. Penicillin uptake on resting staphylococci

results. In these preliminary experiments we assumed that self-absorption of the β-rays by bacteria would be considerable, and accordingly looked for a disappearance of radioactivity from the filtrate, rather than an increase on the bacteria. Further experiments have shown that this self-absorption effect can be eliminated by counting thin films of bacteria, and under these conditions we have been able to detect a penicillin uptake.

Bacteria were suspended under various conditions in radioactive penicillin solutions, centrifuged, washed and the radioactivity on the bacteria measured directly by the Geiger counter, the uptake being expressed as units of penicillin per gm. dry weight of the cells, as this avoids any assumptions regarding size of bacteria, etc., made when calculated in terms of molecules attached per organism. The penicillin uptake is very small, varying from a maximum of 40 units per gm. dry weight down to the smallest detectable amount of 0·5 units per gm., this variation depending on the strain of the organism and conditions of experiment.

Penicillin is taken up by all bacteria in amounts which increase with penicillin concentration in the external environment. In the range of 0–0·5 u./ml., however, there is a marked qualitative difference in the shape of uptake curve for sensitive and resistant organisms (see Fig. 1), so that, at these minimal concentrations, much more penicillin is fixed by sensitive than by resistant bacteria. There is, in fact, a direct correlation between the sensitivity of an organism and the amount of penicillin attached to it. The uptake increases greatly when growth occurs in presence of penicillin (see Fig. 2). However, if growth is halted by cooling, or if the cells are already dead, there is still a rapid but smaller uptake.

The penicillin is strongly and irreversibly attached under all conditions of reaction, and cannot be removed by washing or by incubation for 30 min. with 0·1 per cent cetyl trimethyl ammonium bromide or 'Aerosol OT', 5 per cent phenol, 1 per cent cysteine, 1 per cent sodium hydroxide, *N* hydrochloric acid, 1 per cent glucose or with ordinary penicillin (200 u./ml.); it is, however, removed by heating for five days at 60° C. in water.

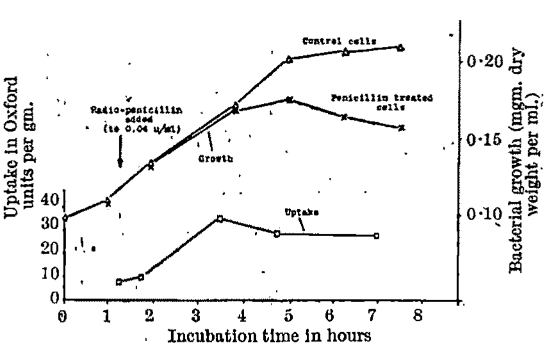

Fig. 2. Rate of penicillin uptake on actively dividing staphylococci

The site at which penicillin is attached to resting cells is not blocked by pre-treatment of the cells with 3 per cent formalin, 0·1 per cent cetyl trimethyl ammonium bromide, 0·1 per cent euflavin, *N* hydrochloric acid, or by autoclaving; but heating for five days at 60° in water or pre-treatment with penicillin or acetic anhydride completely prevents any uptake.

Whatever the nature of the primary site of penicillin action, it is clear from this and other work that rapid growth exposes more centres in the bacteria with which the penicillin can react. The combination must either be by unusually strong adsorptive or by chemical forces.

We are grateful to Dr. E. Lester-Smith for further preparations of radiopenicillin and to Mr. P. Roberts for his help in maintaining the counter.

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Electrophoretic Properties and Analysis of Whale Myoglobin

IN a recent note[1] describing the preparation of whale myoglobin, it was shown that this protein could be crystallized as the carboxy- or met-myoglobin.

In continuation of this work, an electrophoretic study has been carried out using the Tiselius apparatus. The myoglobin was dissolved to give a 1 per cent solution in phosphate buffers of ionic strength 0·1 at *p*H values between 4 and 11. Only above *p*H 11 or below *p*H 4·6 was a single boundary observed. At all intermediate *p*H values two or three boundaries were present.

Globin hydrochloride was prepared by the method of Anson and Mirsky[2], which has already been used with success by Drabkin[3] in the case of horse myo-

Globin of whale myoglobin

(1) N as % protein-nitrogen.
(2) gm. Amino-acid per 100 gm. protein.
(3) Minimal mol. wt. calculated from data in (2).
(4) Assumed number of residues.
(5) Apparent minimal mol. wt. of protein, calculated from data (3) and (4).

	(1)	(2)	(3)	(4)	(5)
Arginine	4·25	2·24	7760	2	15520
Histidine	17·78	11·12	1391	12	16710
Lysine	17·94	15·90	918	19	17450
Glutamic acid	9·74	17·40	845	20	16900
Aspartic acid	3·98	6·41	2068	8	16544
Amide-N (ammonia)	3·35	0·69	2460	7	17220
Methionine	1·03	1·86	7950	2	15900
Tryptophane	2·10	2·60	3921	4	15684
Serine	2·12	2·69	3882	4	15528
Threonine	2·95	4·26	2790	6	16740
Glycine	4·44	4·04	1856	9	16700
Alanine	7·82	8·46	1053	16	16870
Proline	1·70	2·38	4845	4	19380
Phenylalanine	1·98	3·96	4160	4	16640
Leucines	11·30	17·96	729	23	16770
Valine	2·64	3·74	3120	5	15600
Tyrosine	0·96	2·12	8570	2	17160
Cyst(e)ine	0·00	0·00	0	0	0
Hydroxyproline	0·00	0·00	0	0	0
Hydroxylysine	0·00	0·00	0	0	0
Total found	96·08	107·83	—	147	16700 (mean)

globin. The native product became denatured readily, though in two out of six experiments a clear solution was obtained in 3 *M* phosphate buffer at *p*H 7·0. Such solutions nevertheless were too unstable for electrophoretic examination. The denatured globin, which was soluble below *p*H 4·0 and above *p*H 10·0, gave the expected picture of a single sharp ascending boundary with a very diffuse descending boundary.

A preparation of the globin, obtained by precipitating twice with acetone–hydrochloric acid followed by heat coagulation, contained 17·0 per cent nitrogen, corrected for ash. Amino-acid analyses were made by methods in current use in this laboratory, and the results are collected in the accompanying table. The minimum molecular weight would appear to be about 16,700. Application of the end-group assay method of Sanger[4] suggests that the molecule may be a peptide chain bearing a terminal valyl residue.

I wish to thank Prof. A. C. Chibnall for his advice and encouragement, and the "Stiftung für Stipendien auf dem Gebiete der Chemie" for a grant.

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Oct. 29.

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Role of Substances Formed during Germination in the Growth of Plants

IN this laboratory, v. Hausen[1] showed in her doctoral thesis that if the cotyledons of a pea plant are removed after a germination period of five to nine days, and the cotyledonless seedling is transferred into a sterile nutrient solution (the sterile culture system of Virtanen and v. Hausen[2]), it grows at first poorly and small chlorophyll-containing leaves are formed; but growth soon ceases. If crystalline ascorbic acid (30–40 mgm. per pea plant) was added to the nutrient solution (1 litre per pea plant) the plant grew until the flowering stage. Since the cotyledons of the pea at this stage of development contain more than 90 per cent of the vitamin C formed during germination, this experiment gave convincing proof for the conclusion[3] drawn from the previous observations that vitamin C is a growth hormone of plants and indispensable for their life.

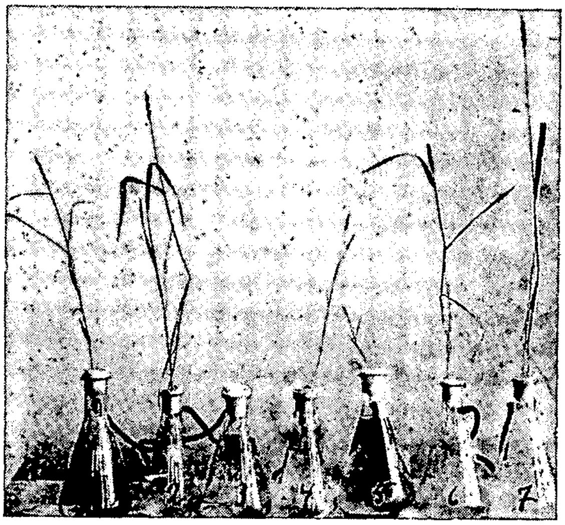
This problem has again been under investigation in this laboratory during the last two years. Saubert-v. Hausen[4] has already reported on experiments which show that the B-complex and biotin also promote to a certain extent the growth of cotyledonless peas. The effect of vitamin C is, however, much superior. The effects of various vitamins are additive.

The purpose of our new experiments has been in the first place to clarify the mode of action of vitamin C. At first we found that large doses of vitamin C (100–120 mgm. ascorbic acid per pea plant, administered in three doses) produced in some cases with cotyledonless seedlings a growth comparable with the normal growth. In the previous experiments with smaller doses of vitamin C (30–40 mgm.) the growth was much weaker. Our experiments showed also that amino-acids and especially the expressed juice of the growing pea promote to a certain extent the growth of cotyledonless peas. The growth was, however, not comparable with the response obtained with vitamin C.

All the experiments reported above were performed in nutrient solutions with calcium nitrate as the source of nitrogen. As the idea that ascorbic acid would function as a reducing system did not seem impossible, we carried out a number of experiments using ammonium sulphate as the source of nitrogen. The experiments were made both with cotyledonless peas and endosperm-free wheat plants. In the wheat grain, the vitamin C content of the embryo increases during two or three days to such an extent that the vitamin C content of the endosperm largely loses its significance. The wheat embryo must therefore be removed from the endosperm at a very early stage in order to obtain a distinct response to the vitamin C addition to the nutrient solution. In our experiments the wheat embryo was excised one or a few hours after the moistening of the seed. From a pea plant, in which vitamin C accumulates in the cotyledons, these were removed four to five days after moistening the seeds.

The results with wheat have shown consistently in all experiments that the excised embryo grows very poorly in a nutrient solution where nitrate is used as the source of nitrogen unless supplied with vitamin C. In a nutrient solution containing vitamin C the growth is again good. When ammonium sulphate is used as the source of nitrogen, the wheat embryo grows fairly well without vitamin C, nor does the addition of vitamin C improve the growth; on the contrary, it depresses growth to some extent (see photograph).

With pea the results in nutrient solutions with ammonium salts are not so distinct and consistent as with wheat. Difficulties are added in the first place by the fact that the pea takes up ammonium ions so rapidly[5] that ammonium salts in amounts injurious to growth are easily accumulated in the



Effect of ascorbic acid and different sources of nitrogen on the growth of isolated wheat germs

No. of expt.	Additions	Source of nitrogen	Dry weight of seedling (mgm.)	Length of shoot (cm.)
1	None	$(NH_4)_2SO_4$	520	37
2	,,		720	46
3	,,	$Ca(NO_3)_2$	11	11
4	,,	,,	123	28
5	,,	,,	38	12
6	Vitamin C	$(NH_4)_2SO_4$	370	37
7	,,	$Ca(NO_3)_2$	542	56

plant. The light conditions and other factors affecting growth determine whether the pea grows well on ammonium salts or whether it withers. All this makes it difficult to carry out experiments on peas with ammonium nitrogen. In any event, even with peas a fairly good growth was induced in some experiments by means of ammonium sulphate without addition of vitamin C, and no improvement of growth resulted from vitamin C administration. In most cases the addition of vitamin C was harmful, perhaps because the oxidation-reduction potential was lowered too much.

The results suggest that the effect of vitamin C in plants is at least partly based upon the reducing properties of this vitamin. Regulation of the redox potential is apparently the important function of this vitamin in plants.

Our results show likewise that the prevailing concept that immediately after the appearance of chlorophyll the plant forms all its organic material through assimilation of carbon dioxide, in other words, is autotrophic for its metabolism, does not as such hold good. The plant needs the substances formed in the seed during germination often for a long time after the development of the first green leaves. This period varies in different plants.

The close dependence of the growth of plants on the substances formed in the seeds suggests that the productiveness of the different varieties of the same plant may perhaps depend on the quantity of such substances formed during germination. The elucidation of this problem, which is of much interest for the breeding work, requires extensive analytical material.

Note added in proof, March 12. Later experiments have confirmed the view that the reducing properties of vitamin C are of high significance. In addition to vitamin C many other substances, such as reductone, cysteine and glutathione in suitable concentrations promote growth in nutrient solutions with nitrate as the source of nitrogen. With ammonium salts these reducing substances are either ineffective or, in somewhat higher concentrations, injurious. Our measurements have also shown that vitamin C as well as other reducing substances added to the substrate lower the redox potential within the plant. Except in the above-described system, we have examined the growth of germs also in the dark on agar substrate which in addition to mineral salts contained 4 per cent[6] cane sugar. Generally the results were in agreement with those above.

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[2] Cf. Virtanen, v. Hausen and Karström, *Biochem. Z.*, **258**, 106 (1933).

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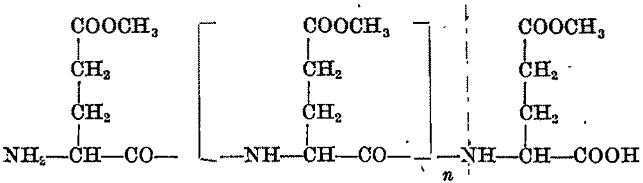
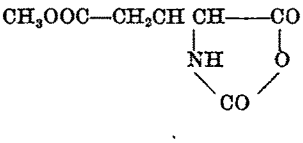
Evidence of Chain Folding in a Synthetic Polypeptide and in Keratin

A STUDY of polypeptides prepared by Leuchs's method[1,2] is being carried out in this Laboratory. We have recently prepared the polypeptide I (below) by the polymerization of the N-carbonic anhydride of γ-methyl L-glutamate (II), and wish to describe here observations which indicate that it has a folded structure as shown in III.



$NH_2-CH(CH_2CH_2COOCH_3)-CO-\left[-NH-CH(CH_2CH_2COOCH_3)-CO-\right]_n-NH-CH(CH_2CH_2COOCH_3)-COOH$

(I)



(II)

A small number of initiating centres were formed by exposing the anhydride to water vapour, and the specimen was left to polymerize in the solid state for three months in a desiccator. The polypeptide prepared in this manner was insoluble in the usual organic solvents; it dissolved readily in formic acid and slowly in *meta*-cresol. The specific viscosity measured in *meta*-cresol was 0·42 ($C = 1{\cdot}00$ gm./100 c.c.), corresponding to a molecular weight of about 30,000.

Films of the polypeptide could readily be cast from hot *meta*-cresol solution; these films were coherent and pliable. A film of the polypeptide was cast on a thin smooth sheet of cadmium and rolled to produce an extension of 500 per cent. After rolling, the film was still coherent and flexible and showed double refraction, the maximum polarizability being in the direction of extension ($\Delta n = 0{\cdot}0076$).

The spectrum of the extended film was examined by a polarizing infra-red spectrometer of high resolving power. The optical density of the specimen could be measured accurately with the electric vector of the incident radiation parallel and perpendicular to the direction of extension[3]. The results obtained in the 3 μ-region of the spectrum for bands which could be accurately analysed are given in the table.

Polyglutamic ester stretching-frequencies

Band frequency	Assignment	Dichroic ratio
3,305 cm.$^{-1}$	N—H stretching (hydrogen-bonded)	1·26
3,076	N—H vibration	1·80
2,851	CH_3 or CH_2 symmetrical stretching	0·60

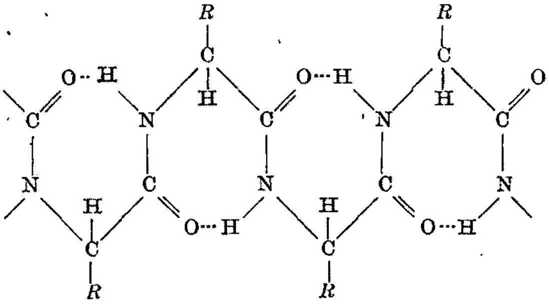
The dichroic ratio is the ratio of the optical density of the absorption band with the electric vector parallel to the direction of extension to the density with the electric vector perpendicular to this direction.

The bands at 3,305 and 3,076 cm.$^{-1}$ are practically identical with those of nylon 66 (3,308 and 3,078 cm.$^{-1}$), and are characteristic of many mono-substituted amides and polyamides. The band at 3,305 cm.$^{-1}$ is due to the N—H stretching-frequency in the hydrogen-bonded state. The band at 3,076 cm.$^{-1}$ may either be an overtone of the 1,550 cm.$^{-1}$ frequency or it may be due to the N—H stretching, accompanied by close hydrogen-bonding such as may occur in nylon. It is certainly an N—H frequency, and has been discussed from this point of view by Astbury, Dalgliesh, Darmon and Sutherland[4].

Polyglutamic ester shows the surprising result that the maximum absorption due to both bands is parallel to the direction of extension, which indicates that the N—H bonds tend to lie parallel to the chain axis. The dichroic ratio is not large and suggests merely a preferred orientation of the N—H bond towards the chain axis. By examining the specimen with the radiation incident in several different directions, it has been shown that the above result is not due to the unlikely event of the chains being oriented perpendicular to the direction of rolling. Preliminary observations on the band at 1,650 cm.$^{-1}$ due to the peptide C : O stretching-frequency also indicate that the C : O bond is parallel to the chain axis.

In a rolled specimen of nylon 66 [3], both the N—H bands and the C : O band show stronger absorption perpendicular to the chain axis, as is to be expected in the extended form of the chain where the N—H bonds lie in planes perpendicular to the chain axis.

These results can be explained if the peptide chain is folded and maintained in the folded state, in spite of the extending force, by *intra*-chain hydrogen-bonding between the N—H and C : O groups (III), in which the N—H groups are inclined towards the chain axis.



(III)

It is likely that this folding is a direct consequence of the steric hindrance to *inter*-chain hydrogen-bonding, produced by the bulky side-chains. The folding of peptide chains in natural proteins has, of course, been suggested by Astbury[5]. Picken[6] has suggested that protein chains can exist in various configurations with the same internal energy, the extended form being the least probable. The folded configuration proposed for rolled polyglutamic ester should possess the same internal energy as the *inter*-chain hydrogen-bonded peptide. It may be that this folded structure exists largely in the non-crystalline regions of the polymer.

Results similar to the above have been obtained with a polyglutamic ester of molecular weight about 15,000 prepared by polymerization in solution.

Polarized infra-red observations of the highly oriented α-keratin obtained from the quill tip of *Atherurus africanus* have also given results similar to the synthetic polypeptide. MacArthur[7] has shown that porcupine quill is one of the most highly oriented available forms of α-keratin. The infra-red results indicate that α-keratin is also folded in the same way as the synthetic polypeptide and forms an extended ribbon-like molecule. The side-chains and seven-membered rings will both lie approximately in the plane of the ribbon. Huggins[8] has suggested the possibility of a similar seven-membered ring for α-keratin, but has adopted a different arrangement of the *R* and H groups about the asymmetric carbon atom. He also favours an arrangement with close spiralling of the ribbon. A spiral structure in a closely packed system does not seem to be consistent with the ease of effecting the α-β transformation, and a close spiral certainly will not account for the infra-red results.

Infra-red and X-ray investigations are now being carried out on other synthetic polypeptides and proteins.

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Structure of Chitosamine

In a recently published paper[1], it was shown that a number of aldose sugars are oxidized at characteristic rates by the action of hypoiodous acid. The rate of oxidation appears to be related to the structural configuration for any particular aldose; thus glucose and xylose show a similar rate of oxidation, which is, however, different from that shown by galactose and arabinose, and different again from that shown by mannose. The magnitude of these variations in the rate of oxidation is sufficiently great to enable a positive identification of the configurational group to which any one of these aldoses may belong. This work (*loc. cit.*) suggested that kinetic measurements of the hypoiodous acid oxidation of sugar derivatives of the aldose type might yield valuable information on the structure of such derivatives.

Chitosamine hydrochloride, for a pure sample ($\alpha_D^{20} = +72{\cdot}5$) of which, prepared from the carapace of *Jasus Lalandii*, I am indebted to Dr. J. B. Polya, was submitted to the oxidation procedure, and its rate of oxidation found to coincide closely with that of the galactose–arabinose group of aldoses. The experimental results are shown in the accompanying table, glucose and mannose being added for purposes of comparison.

Time of quarter change (sec.)

*p*H	Chitosamine hydro-chloride	Galactose	Arabinose	Glucose	Mannose
10·55	4·25	4·25	4·25	6·5	28
10·95	3·25	3·25	—	4·5	18·5
12·80	15·0	16·25	16·0	32·0	175

This result is surprising, since the configuration of chitosamine has generally been accepted on what appears to be reliable evidence as that of glucose[2].

The results reported here may indicate, therefore, that chitosamine in strongly alkaline solution exists in some other modification than a pyranose ring (possibly a high percentage of the free aldehyde form), since only those aldoses which have a pyranose ring have been studied in previous oxidation experiments[3]. The products of the oxidation reaction are at present being examined with the view of clarifying this point.

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[2] Annual Reports, 78 (1922). Micheel and Micheel, *Ber.*, **65**, 253. Haworth, Lake and Peat, *J. Chem. Soc.*, 271 (1939).

[3] *loc. cit.* See also Myrbäck, *Svensk. Kem. Tidsk.*, **51**, 7, 74, 149, 179, 206, 225 (1939); **52**, 21, 200, 293 (1940).

Stability of Aminobenzyl-Quaternary Salts

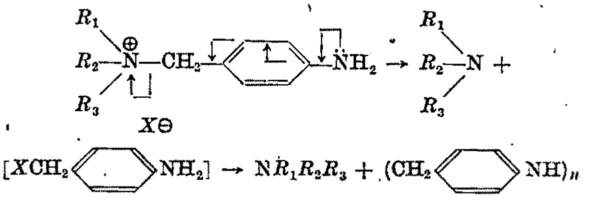
While engaged in the preparation of benzyl-quaternary salts of a number of N-heterocyclic ring systems, the abnormal instability of some salts containing the aminobenzyl group was observed.

When, for example, *o*- or *p*-nitrobenzylquinolinium chloride was reduced under neutral conditions (ferrous hydroxide or iron powder and water), the desired amino-compound was difficult to isolate, and the only recognizable product (yield *c*. 80 per cent) was quinoline. The first conclusion, that here was a particularly facile case of reductive debenzylation, had to be abandoned on further investigation. Thus, when *p*-nitrobenzylquinolinium chloride was hydrogenated in aqueous solution in the presence of palladium–charcoal and more than one mole of hydrochloric acid, six hydrogen atoms were absorbed, and the filtrate could be evaporated in a vacuum at a low temperature to leave *p*-aminobenzylquinolinium chloride hydrochloride as almost colourless hygroscopic crystals. In the dry state this was fairly stable over several weeks, and in solution it could be diazotized normally and coupled, for example, with β-naphthylamine in acid solution. The colourless solution of the hydrochloride, on treatment with sodium acetate, turned orange and deposited orange-yellow needles of the free amino-compound. This had a very low order of stability. It could be dried rapidly in a vacuum and analysed, but could not be recrystallized; warmed gently with water, it first dissolved but then rapidly decomposed to give quinoline in high yield and a brown amorphous material. In the dry state decomposition was apparent after a few days. Acetic anhydride converted the aqueous suspension into *p*-acetamidobenzylquinolinium chloride, a crystalline substance stable to boiling water.

On the other hand, *m*-aminobenzylquinolinium chloride hydrochloride, prepared in a similar manner to the *p*-isomer, was a non-hygroscopic substance, the aqueous solution of which was quite stable to boiling after the addition of sodium acetate. The free amino-quaternary iodide formed orange-red crystals from methanol.

Further work has since shown similar properties (*p*-amino, unstable; *p*-acetamido- and *m*-amino, stable) in the aminobenzyl-quaternary salts of *iso*quinoline, pyridine and phenyldimethylamine, as well as a number of *bz*-substituted quinolines. In the case of *p*-aminobenzylpyridinium chloride, the facile decomposition was probably observed by Lellmann and Pekrun[1]; but the significance was not explained.

It is suggested that the explanation for these observations may be that shown diagrammatically below; the strain in the benzyl-N bond due to the



presence of the adjacent positive charge is magnified to the point of actual rupture by the electromeric effect of a *free* amino-group in the *o*- or *p*-position. The greater stability of the *m*-isomer as well as that of the salts and acetyl-derivatives of the *o*- and *p*-isomers follows logically, while the amorphous substance which always accompanies the tertiary amine is seen to be probably the polymeric benzylene-imide.

It is hoped to publish fuller details of this work later.

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Sept. 17.

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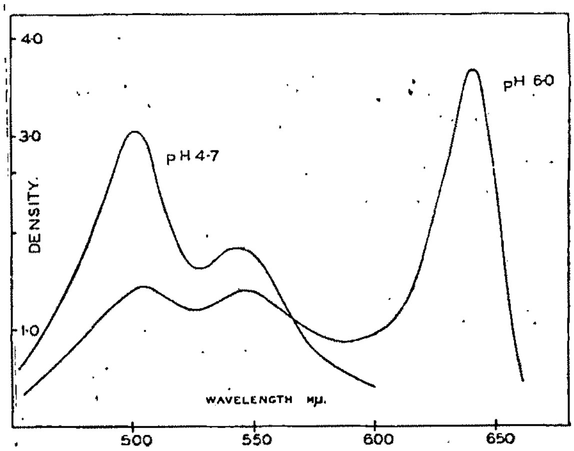
Use of Dyes to Determine the Iso-electric Point of Gelatin

The effect of small concentrations of gelatin on the absorption characteristics of aqueous solutions of certain carbocyanine dyes has been reported by Sheppard[1] and Solovyev[2].

During an investigation of some of the factors influencing the adsorption of these dyes to proteins, it was noted that the adsorption is electrostatic in character and depends upon the *p*H of the gelatin solution. Certain dyes exhibit a narrow and intense absorption band in the red region of the spectrum in dilute gelatin solutions (0·01 per cent) if the *p*H is above the iso-electric point. Below the iso-electric point the absorption is similar to that of the aqueous dye solution. The colour change is sharp and is illustrated by the absorption curves in the accompanying diagram.



The absorption of 1 : 50,000 3 : 3′-dimethyl 5 : 5′-dichloro-9-ethyl thiacarbocyanine chloride in 0·01 per cent aqueous gelatin solution at two *p*H values

This effect provides a quick and convenient method for the determination of the iso-electric point of gelatin. The following technique has been found to give reliable and reproducible results. Several dyes were examined and the one selected was chosen for sharpness of end-point.

To 50 ml. distilled water add 0·5 c.c. of 1 per cent gelatin solution followed by 0·5 c.c. of 1 : 2,000 ethyl alcohol solution of 3 : 3′-dimethyl 5 : 5′-dichloro-9-ethyl thiacarbocyanine chloride. If, as usual, the *p*H of the solution is above the iso-electric point, the colour will be blue. *N*/100 hydrochloric acid is added from a micro-burette until the colour of the solution changes from blue to red. Each addition of acid is followed by thorough stirring of the solution. The end-point is reached when the last trace of blue colour just disappears from the solution. Measurement of the *p*H of the solution at this stage gives the iso-electric point. If the end-point is overshot, addition of a slight excess of alkali will enable the titration to be repeated, and by this method several estimations can be made on one sample.

A comparison of the dye method with the spirit precipitation method[3] is given in the following table, using four different gelatins. The figure given for the dye method is the mean of four estimations.

Gelatin	Iso-electric point	
	Dye	Spirit precipitation
A	*p*H 5·05	*p*H 4·95
B	4·75	4·75
C	4·87	4·85
D	5·05	5·05

The end-point with acid-washed gelatins of high iso-electric point (*c.* 8·0) is not so sharp, but with these gelatins the spirit precipitation method also gives indeterminate results. The dye method has the advantage that an estimation can be made on as little as 5 mgm. of the gelatin.

Thanks are due to the directors of Ilford Limited, for permission to publish this note.

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Sept. 20.

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Inhibition of the Low-Temperature Polymerization of *iso*Butene

R. M. THOMAS *et al.*[1] have stated that the presence of olefines diminishes the yield of the low-temperature polymerization of *iso*butene by Friedel–Crafts catalysts and also reduces the molecular weight of the product. Plesch, Polanyi and Skinner[2] have reported that ethanol or diethyl ether inhibit the same reaction when using titanium chloride ($TiCl_4$) and traces of water as catalyst, even if the titanium chloride is in excess of the inhibitor; and Plesch[3] has shown acetic acid to be an inhibitor. Norrish and Russell[4] have reported that the rate of the low-temperature polymerization by stannic chloride is decreased by ethanol, *t*-butanol, diethyl ether, acetone, butene-1 and butene-2; and that the first four of these substances also reduced the molecular weight of the product.

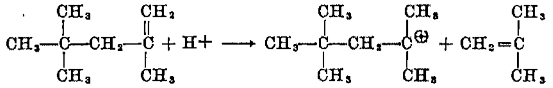
We have investigated the effect of inhibitors on the low-temperature polymerization of *iso*butene by boron trifluoride (BF_3). The reactions were carried out adiabatically and were followed in terms of the temperature rise, due to the heat of polymerization, by means of a thermocouple. The reaction vessel was part of a vacuum system, and the required volume (50 ml.) of monomer solution in hexane (10 per cent vol./vol.) could be syphoned into it from the reservoir with complete exclusion of the atmosphere. The inhibitor was added by condensing into the reaction vessel a known quantity of the inhibitor vapour. When the mixture of solvent, monomer and inhibitor had been brought to a temperature near − 65° C., the reaction was started by circulating a fixed volume of boron trifluoride and nitrogen (containing $7 \cdot 5 \times 10^{-3}$ gm. mol. BF_3) continuously through the solution. This circulation was carried out by an all-glass magnetically operated pump working in a closed circuit.

The mean molecular weights of the polymers were calculated from the intrinsic viscosities of their solutions using the Houwink equation[5] and the constants determined by Florey[6]. The yields were measured both by estimating the bromine consumed by the residual monomer and by weighing the polymer precipitated in alcohol and dried.

The yield of polymer was high (88–100 per cent) and not affected by the inhibitors used. In the absence of inhibitor, the reaction-rate decreased monotonically from its initial maximum value, the temperature rise (24–27° C.) was completed in 35–45 sec., and a product of molecular weight 40,500–55,000 was obtained. The presence of *t*-butanol and ether produced markedly *S*-shaped time–temperature curves analogous to those observed in free-radical polymerizations and possibly having a similar explanation[7].

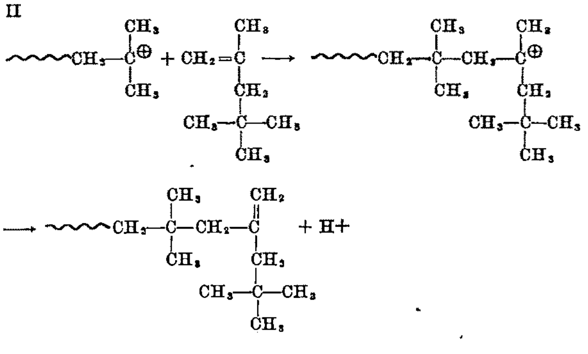
With 3×10^{-3} gm. mol. *t*-butanol or ether present, the time of reaction increased to 160 and 200 sec. respectively, and in the case of *t*-butanol gave molecular weights of polymer of 11,100–13,700. The addition of the same quantity of di-*iso*butene (a mixture of 2,4,4-trimethyl pentene-1 and -2) reduced the molecular weight to 5,600 but left the reaction time at 40 sec., as in the uninhibited experiments. Thus *t*-butanol and di-*iso*butene both increase the rate of chain termination; but *t*-butanol reduces the rate of chain initiation (by complex formation with boron trifluoride), and di-*iso*butene leaves this rate unaffected. A possible explanation of the di-*iso*butene case in terms of the carbonium ion theory of Friedel–Crafts polymerizations[8,2] and the steric properties of the structures involved is that an activated di-*iso*butene molecule may start a chain (I), but the incorporation of di-*iso*butene in a growing

I



⟶ Uninhibited propagation.

II



Further propagation sterically inhibited by neopentyl group.

chain (II) terminates the latter due to the steric hindrance to any further step[9,10].

The terminated chain in II can start another chain by proton transfer, thus permitting an original initiation process to cause the same total amount of polymerization with and without di-*iso*butene but giving lower molecular weights in its presence.

We are informed by A. G. Evans and G. W. Meadows that they have established the occurrence of a high degree of chain transfer for the reaction of *iso*butene in the presence of boron trifluoride–cocatalyst complexes. Their results have been submitted for publication elsewhere[11].

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Streaming Potential in Paper Chromatography

The net resultant flow of solvent through the capillary channels of paper used in chromatography is in a direction away from the point of feed; and it was therefore considered possible that such a system might result in the setting up of a streaming potential[1].

This has been verified experimentally in some cases, using water and inorganic salt solutions: distilled water flowing through a washed and dried strip of No. 3 Whatman paper showed a potential gradient of approximately 10 mV. per cm. measured by a Cambridge *p*H meter. With 1 per cent thorium nitrate solution in place of water, the potential was reduced almost to zero. 1 per cent sodium chloride solution showed a potential gradient of approximately 4 mV. per cm. Various factors, such as rate of flow of liquid, and nature of electrodes used in making the measurements, may affect the values considerably.

Such potentials (or their causes) may well exert a marked effect on the process of chromatographic development, and preliminary experiments in which the potentials have varied have given interesting indications. For example, development of 0·01 ml. of 0·1 per cent aqueous solution of a mixed colour (Edicol Green 37113, I.C.I., Ltd.) with distilled water failed to separate the components, the band moving with the solvent front, whereas development with 1 per cent sodium chloride solution achieved complete separation into blue and yellow bands. Very dilute solutions of aluminium chloride and thorium nitrate caused strong adsorption of both components, which is difficult to attribute to 'salting out' effects[2] in view of the low salt concentrations, and more probably relates to changes in the electric double layer.

Indications have been observed using either the strip or central feed technique[3] that the flow of one liquid over another occurring in 'partition' chromatography may result in streaming potentials of varying sign, which may be significant in considering possible mechanisms of 'partition' separations.

A study of the above and related phenomena is in progress and will be reported more fully elsewhere.

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Dielectric Properties of the Human Body in the Microwave Region of the Spectrum

As a preliminary to a detailed study of the reactions of certain body tissues to electromagnetic radiations on centimetre wave-lengths, it has been found desirable to determine the propagation characteristics of such waves in various parts of the body.

The specimens were obtained in most cases from surgical operations, being selected for homogeneity and cut into sections suitable for insertion in a wave-guide cell. In this cell the specimen was trapped between a tight-fitting plug of polystyrene one half wave-length in thickness and a reflecting metal plunger driven on a micrometer screw thread. The cell was surrounded by a bath of water thermostatically controlled at a temperature of 37° C. to an accuracy of $\pm \frac{1}{2}$° C.

From measurements on the standing wave pattern set up in the wave-guide feeding the cell, two constants α and β for the medium were determined by a method similar to that used by Roberts and von Hippel[1]. The parameter α is the absorption coefficient and is expressed in nepers/cm. The parameter β is the phase constant expressed in radians/cm. and is a measure of the velocity of the wave in the medium. To a first approximation the dielectric constant of the medium can be taken as proportional to β^2.

The following representative body constituents have been measured in this way at a wave-length of 3 cm., several thicknesses from various specimens being used where practicable (Table 1).

The results quoted in Table 1 should have a measurement accuracy better than ± 5 per cent in α and ± 1 per cent in β; but the difficulty of repeating biological specimens accurately should be appreciated. Measured in the same equipment, the corresponding constants for distilled water at 37° C. were $\alpha = 2{\cdot}70$ and $\beta = 16{\cdot}0$, which are in good agreement with those obtained by Collie, Hasted and Ritson[2].

Examination of the results for biological materials leads to the following general conclusions.

(1) The absorption coefficients at 3·18-cm. wave-length for a large number of body constituents are substantially the same as that of water at the same temperature. Fatty tissue and bone have a considerably lower absorption, and are relatively transparent to the radiation.

(2) The phase constants for a large number of body constituents fall into a group with a rather lower average value than that of water. Small, but significant, differences occur within the group, presumably attributable to the variation of water content. This is demonstrated by results taken on

Table 1

Specimen	α (nepers/ cm.)	β (radians/ cm.)	Remarks
A. Normal			
Whole blood	2·90	13·5	Uncoagulated by 1/500 mgm. heparin
Skin 1. Breast	2·65	12·1	Free of areolar tissue
2. Leg	2·55	11·8	
Muscle (skeletal)	2·50	11·7	Stripped of fascial sheath
	2·70	11·6	
Sigmoid colon	2·75	13·5	Sections included muscle coats, but no serous coat
	2·70	13·4	
Tænia coli	2·85	13·6	
Thyroid gland	2·70	13·7	Hyperplastic
	2·85	13·5	
	2·65	13·5	
Prostate gland	2·70	13·7	Hyperplastic
	2·50	13·7	
Fat 1. Breast	0·49	4·0	Free of areolar tissue
2. Leg	0·44	4·0	
Bone (femur)	0·56	5·4	Specimens obtained from a post-mortem examination Bone machined accurately to fit wave-guide
	0·56	5·4	
Bone marrow	0·79	5·1	
B. Malignant			
Carcinoma of breast (scirrhus)			
(*a*)	2·70	13·1	Sections were taken from four different tumours and all were confirmed scirrhus carcinoma of breast by histological examination. The only difference revealed was in the degree of fibrous stroma present in each tumour section
	2·75	12·5	
(*b*)	3·0	13·1	
	3·2	13·0	
(*c*)	2·75	12·5	
(*d*)	2·65	12·5	

Table 2

Specimen	Corpuscle concentration (× 10^6 per c.mm.)	Radians/cm.	Dielectric constant relative to air
Blood serum	—	15·2	57
Whole blood	4·9	13·5	45
Corpuscles in high concentrations	17·1	12·7	40

whole blood and its products after centrifuging (Table 2).

Fatty tissue and bone have correspondingly lower dielectric constants, of the order of 4·5 and 8·0, respectively.

(3) At this wave-length no significant difference may be expected in the behaviour towards the radiation of malignant and non-malignant tissue. It is to be expected that the effect of the polar water molecules will overshadow any changes which may result from biologically different structures.

Consider 3-cm. wave-length radiation falling normally from outside on an area of the body, which can be treated for this purpose as a uniform and infinitely extended medium with average values of the constants α and β. Calculation shows that approximately one-third of the incident power will be absorbed by the body, the remainder being reflected. The high value of the absorption coefficient indicates that the majority of the absorbed power will be dissipated initially in the first few millimetres of skin. The resulting heat distribution will normally be modified by conduction and by the action of the vascular system.

These dielectric measurements are being extended to 10-cm. and 1·25-cm. wave-lengths.

The work has been carried out at the Royal Victoria Infirmary, Newcastle upon Tyne, with the aid of a grant from the North of England Council of the British Empire Cancer Campaign. The assistance of Ministry of Supply, Telecommunications Research Establishment, in supplying electronic equipment is also gratefully acknowledged.

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Wound Extracts and their Effects on the Growth of Hen Fibroblasts

STERILE, healing wounds (rats) were extracted with physiological salt solution. Extracts were made from wounds of ages from 1 to 12 days. The extract was dialysed with several changes of distilled water at a low temperature in a 'Cellophane' tube. In this way the albumin and globulin fractions of the extracts could be separated. Both solutions were then brought to *p*H 6·5–7 and diluted to the same dry-weight concentration. The usual heart fibroblast cultures in Carrel flasks and Carrel glasses were later treated with the prepared extracts. The results are given in Fig. 1, in which the zero horizontal line represents the usual index of increase for the corresponding control culture. A minus index means growth inhibition, and a plus index represents increase of growth.

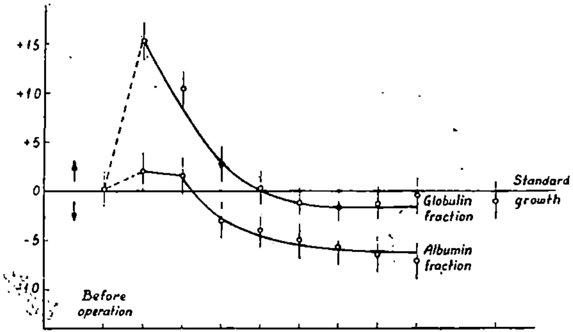
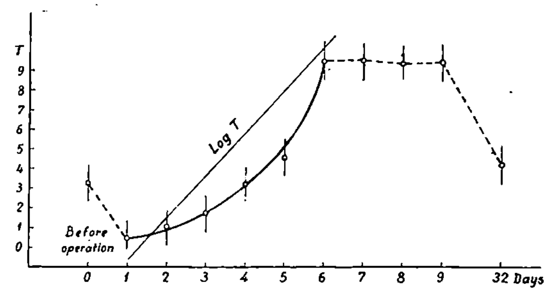


Fig. 1

The power of the wound to combine with basic dyestuff was also investigated. By a previously developed method (Balazs) the amount of dyestuff that the tissue bound was quantitatively ascertained. Frozen sections of wound preparations (100 μ) were later weighed and laid in a specific concentration of toluidine blue in water solution. The preparation



$T = 10^{-3}$ mgm. dyestuff per mgm. tissue
Fig. 2

remained in this solution for 24 hours at + 3° C. Then the concentration of the coloured solution was ascertained photometrically, and from the figures obtained the amount of dyestuff absorbed per mgm. tissue was calculated. The results are given in Fig. 2.

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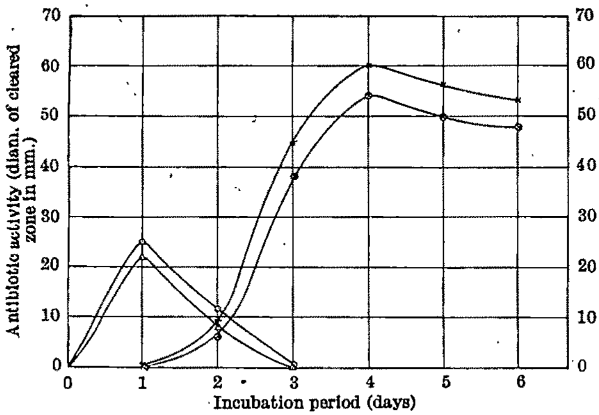
Antibiotic Activity as Shown by a Highly Amylolytic Strain of *Bacillus subtilis*

In the course of an investigation on the formation of amylase by *Bacillus subtilis*, it was observed that the organism, when grown on wheat bran medium, showed a pronounced antibiotic activity. The maximum activity was found in the aqueous extract from a 24-hour-old culture. The amylase formation during this period was found to be low, but steadily increased with further incubation. This phenomenon led to a study of the relationship between the antibiotic production and amylase formation by *B. subtilis*[1] (N.C.T.C. : 2027 *N*) when grown on wheat bran.

The production of substances of antibiotic nature by *B. subtilis* has been studied by earlier workers. It has been shown that three compounds, bacillin, subtilin and bactracin, which are characterized by their bacteriostatic and lytic actions on different Gram-positive and Gram-negative organisms, are synthesized by the various strains of *Bacillus subtilis*. Recently, work has been conducted employing wheat bran as a whole or wheat bran extracts for culturing *P. notatum*[2,3]. These observations indicate the possibility of increasing the penicillin yield by about 60 per cent. It has been suggested that as wheat bran has a fairly high fat content, the fatty acids liberated during the growth of fat-splitting organisms are responsible for the antibiotic action. No direct proof has, however, been advanced to demonstrate the origin of the antibiotic substances from fatty acids.

Bacillus subtilis was grown on wheat bran (10 parts) moistened with the phosphate buffer solution (*p*H 7·0; 25 parts) for the production of amylase[4]. A control series using de-fatted wheat bran was also run along with the experimental series. The extracts were made with water (25 parts) at intervals of every 24 hours. The mass was then strained through cheese cloth and the extract filtered through Whatman's filter paper No. 42. The amylase and antibiotic activities of the clear filtrates were then determined. The antibiotic activity was tested against *Staphylococcus aureus*, by the cup assay method[5]. The results obtained are given in the accompanying table.



Amylase and antibiotic activity of *B. subtilis*. ×—×—, ⊙—⊙—, wheat bran whole; ⊕—⊕—, △—△—, wheat bran de-fatted

Age of the culture (days)	Amylase activity (units per ml.)		Antibiotic activity (diameter of the zones in mm.)	
	Whole wheat bran	De-fatted wheat bran	Whole wheat bran	De-fatted wheat bran
1	Negligible	Negligible	25·0	22·0
2	9·0	6·5	11·0	8·0
3	45·0	38·0	Negligible	Negligible
4	60·0	54·5	,,	,,
5	55·5	50·0	,,	,,
6	53·0	48·0	,,	,,

The results show that an active strain of *B. subtilis* is able to synthesize antibiotic substances during the earlier stages leading to the production of amylase. This antibiotic activity cannot be attributed to the liberation of fatty acids, because the activity is developed even on de-fatted bran.

The antibiotic activity is at a maximum on the first day of growth and gradually disappears with extended incubation. On the other hand, amylase production, which is negligible on the first day, steadily increases as the incubation period proceeds, and reaches its peak value on the fourth day. These observations show that there is some relationship between the production of antibiotic substances on one hand and amylase formation on the other. Probably the secretion of antibiotic substance at an earlier stage serves to prevent invasion by undesirable organisms. In the light of the observations already made by Rao and Murti[6], the lag phase in amylase formation may bear some relation to the development of antibiotic substances. Further work in this direction is in progress.

My thanks are due to Prof. V. Subrahmanyan for his interest and guidance.

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Origin of the Radio Frequency Emission and Cosmic Radiation in the Milky Way

Recent measurements by Hey, Parsons and Phillips[1] on the angular distribution of the galactic radio-frequency radiation at 64 Mc./s. and particularly the observations by these authors, by Bolton and Stanley[2,3] and by Ryle and Smith[4] on variable sources of radio-frequency radiation in low and high galactic latitudes strongly suggest a revision of current ideas on the origin of this radiation.

The interpretation of galactic radio-frequency radiation by free-free transitions of electrons in the interstellar gas, as advanced by Reber, Henyey and Keenan[5] and also adopted by myself[6], besides being obviously unable to explain the variable radiations now meets with the following difficulties :

(*a*) The explanation of the intensity and angular distribution at 20–30 Mc./s. requires the assumption of an electron temperature of 100,000–200,000° K., as Townes[7] and the present author[6b] noticed independently. On the other hand, we know that even in planetary nebulæ with central stars of more than a hundred thousand degrees, the temperature of electrons is kept as low as approximately 10,000° by collisions with oxygen. (*b*) The observed 'concentration' of the radiation in galactic latitude is too small, that towards the galactic centre too strong.

Let us now examine the assumption—which hitherto has mostly been rejected—that the galactic radio-frequency radiation originates in some particular type of stars. Comparing the 'radio-isophotes'[1] of the galaxy with the visual ones of Hopmann[8]—taking roughly into account the obscuration by dark nebulæ—we find that an *average* mag. 1 star (visual scale) emits about 2×10^{-23} watts per m.^{2} per c./s. (afterwards simply called a 'unit').

The discrete sources[1,2,3] emitting 6×10^{-23} (Cygnus) to 2×10^{-24} (Hercules) units cannot, so far, be identified with any reasonable objects on Bottlinger's Galactic Atlas; these should therefore be fainter than mag. 6. For them, therefore, a mag. 1 object would emit *more* than 6×10^{-21} to 2×10^{-22} units. On the other hand, the sun (mag. − 27, visual) emits approximately 13×10^{-23} units—taking the 'quiet' radiation with an effective temperature of $1 \cdot 5 \times 10^{6}$ degrees; slight perturbations are sufficient to increase this figure by several powers of ten. Using the first 'standard' figure, we obtain for a mag. 1 star approximately 8×10^{-34} units.

It seems at first quite incredible that the ratio of 64 Mc./s. radiation to visual light should be $2 \cdot 5 \times 10^{10}$ times higher for an average star and probably more than 10^{13} times higher for some of the discrete sources than it is for the sun. In reality, however, there is nothing impossible about the idea that the sun is an extremely weak radio-frequency radiator.

During the great solar eruption of July 25, 1946, according to Lovell and Banwell[9] the radiation on 72 Mc./s. increased temporarily to an effective temperature of 8×10^{11} °K., that is, by a factor of $5 \cdot 3 \times 10^{5}$ compared with our adopted 'normal' value. Considering, moreover, that the area of the eruption observed by Ellison[10] in $H\alpha$ was only 1/800 of the visible hemisphere, and that for a star with a surface temperature of 3,000°, for example, the surface area per unit visual light is about ninety times larger than for the sun, a total extra-factor of 4×10^{10}, or even somewhat more for a star with strong eruption-activity, appears quite possible.

The low galactic concentration of radio-frequency emission[1] indicates that it originates not in the high-temperature *O* and *B* stars showing high concentration towards the galactic plane, but in late-type stars, probably connected with Baade's population II. This hypothesis is favoured by the strong radio-frequency radiation of the galactic nucleus consisting of population II stars[11]. In addition, it should be noted that the spectra of many late-type stars exhibit indication of an 'activity' much superior to that of the sun, that is, strong emissions within the Ca^{+}, H and K absorption lines; broad hydrogen emissions superposed by metallic absorption lines as in solar eruptions[12], etc. Since even large solar eruptions give very little change of visual light, we should not expect necessarily to find great visual light variations in objects emitting a changing radio-frequency radiation.

Some difficulty might be derived from the fact that the frequency distribution of the galactic radiation is somewhat different from that of the sun. However, observations by Allen[13] on the angular distribution of the sunspot-radiation at 200 Mc./s. (derived from Fig. 4, ref. 13) indicate that this is emitted at a radio-optical depth of approximately 4. Quite plausible differences among the absorbing layers of different types of stars thus appear amply sufficient to account for the observed differences of the radio-spectra.

Our hypothesis of the great abundance of stars the radio-frequency emission of which is roughly 10^{11} times higher than that of the sun gains increased interest in connexion with Forbush's[14] and Ehmert's[15] discovery of cosmic radiation emitted by solar flares. For the strong eruption of July 25, 1946, Forbush—measuring two-hourly means—observed an increase of cosmic radiation by 15 per cent. Let us compare now the 64-Mc./s. radiation for this eruption of about 5×10^{-20} (to 5×10^{-19}) units with that of the whole sky. Using the 'isophotes' given by Hey, Parsons and Philips[1], I get an average intensity of roughly 5×10^{-21} units per unit solid angle, or $6 \cdot 3 \times 10^{-20}$ units altogether. Thus the ratio of eruption-radiation to everyday radiation is almost the same for the 64-Mc./s. radio-frequency radiation and for the cosmic radiation primarily consisting of charged particles.

Taking the average over 3·2 years, Ehmert's coincidence-counting indicates a solar contribution of 0·07 per cent to the cosmic radiation, a figure which for various reasons might be increased somewhat. Taking the average radio-frequency radiation of the sun to be ten times this normal, that is, $1 \cdot 3 \times 10^{-21}$ units, this is about 2 per cent of the radiation of all the galaxy. Again, the idea of a general proportionality between cosmic radiation and radio-frequency radiation is confirmed.

Since the cosmic radiation undergoes considerable changes within the uppermost few cm. of mercury pressure of our atmosphere, we must in any case assume that it originates in the tenuous outer parts of some cosmic structures. The hypothesis of its origin in supernovæ would lead us to expect a great increase of cosmic radiation in connexion at least with every galactic supernova. In fact, an eruption like that of Tycho's nova in 1572, which at maximum was about 400,000 times brighter than most extra-galactic supernovæ, should have increased the cosmic radiation so much as to produce great biological effects which could not have been overlooked.

On the other hand, within the frame of our hypothesis, the problem of a sidereal time variation of the cosmic radiation should be investigated more closely. In any event, the magnetic field of the earth and perhaps also cosmic fields of force[16] will smooth out considerably the angular distribution of the primary cosmic radiation coming from the galaxy.

Altogether our central hypothesis that the radio-frequency radiation of the galaxy as well as the cosmic radiation originate in (late type) stars showing eruption-activity like the sun, only roughly on a 10^{11} times larger scale, has much to recommend it. The detailed physical mechanisms for the production of both radiations remain to be investigated; no doubt large-scale magnetic fields changing in vast layers of tenuous ionized gas play an important part (see refs. 17, 18, 19). Applying Faraday's law of induction, it is evident[18] that changing solar magnetic fields can at most produce 10^{9}–10^{10} eV. The observation of energies up to 10^{15} eV. points toward the existence of much larger spots, etc., in stars in agreement with our previous assumptions.

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Maintenance of Nocturnal Ionization

THE rate of change of ionization in the F_2 ionospheric layer is considered to follow the equation

$$dn/dt = q(t) - \alpha n^2, \qquad (1)$$

under the assumption that the layer is electrostatically neutral and that the net rate of attachment[1,2] is negligible. In (1), n is the number of electrons/cm.^{3}, α is the coefficient of recombination (cm.^{3}/sec.) and $q(t)$ is Chapman's ionization function[3]. During darkness $q(t) = 0$; whence upon integration equation (1) becomes

$$1/n = \alpha t + C_1. \qquad (2)$$

It is well established that during the absence of solar radiation the decrease in ionic concentration does not follow equation (2) exactly. In an effort to provide a better explanation of the nocturnal concentration of ions in the F_2-region, the following theory was developed.

A diurnal temperature variation is assumed to exist at the height of the F_2-layer such that

$T = T_m$, from 2 hours after sunrise to 2 hours before sunset;
$T = T_m \exp(-2ft)$, from 2 hours before sunset to sunrise;
$T = \varphi(t)$, from sunrise to 2 hours after sunrise. (3)

These assumptions are consistent with the theory of radiative equilibrium put forward by Godfrey and Price[4], and other workers in this field. The constant f may be easily evaluated employing $T = T_0$ at sunrise, and t as the time elapsing between the occurrence of T_m and T_0.

From relationship (3) it is easily ascertained that the corresponding pressure function as evaluated from the hypsometeric equation is given by

$$P = P_m \exp(-2f(g+1)t, \qquad (4)$$

where g is a constant empirically determined. The value P_m is that computed when $T = T_m$.

Obviously, under the assumed nocturnal temperature decrease, an atmospheric contraction occurs at the level of the F-layer. We make the logical assumption that the influx of electrons/cm.^{3} is proportional to the influx of total particles/cm.^{3}.

Now define an 'influx function'

$$s(t) = (n/N)\, dN/dt, \qquad (5)$$

which governs the increase in ionic concentration brought about by atmospheric contractive effects. N is the total number of original particles/cm.^{3}.

Under the above conditions, the equation for the rate of change of ionization during the absence of solar radiation becomes (neglecting meteoritic and other possible ion sources)

$$dn/dt = s(t) - \alpha n^2. \qquad (6)$$

It is further recalled that under conditions of volume recombination such as exist in the ionosphere, it is possible to write[5]

$$\alpha = aT^{1/2} = aT_m^{1/2} \exp(-ft), \qquad (7)$$

where T is the electron temperature (° K.). It is permissible to employ equation (7) if it is assumed that the velocity distribution of the electrons, ions, and other particles follows a Boltzmann distribution, and that all particles are in thermal equilibrium.

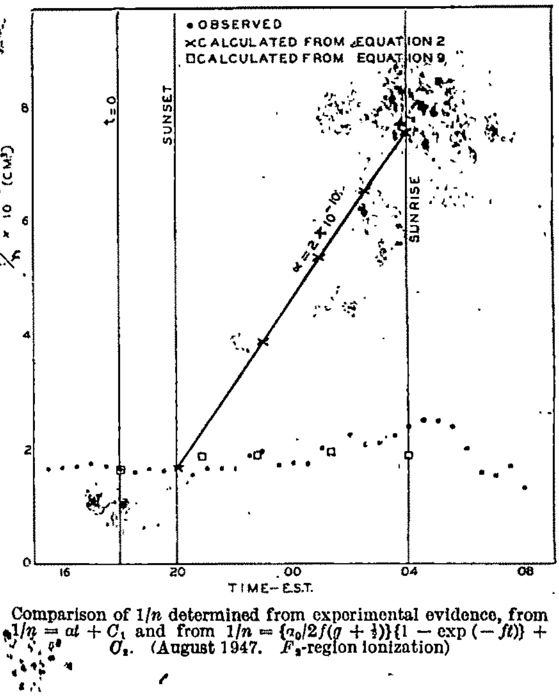
The complete recombination equation during darkness, taking cognizance of the dependence of the recombination coefficient on temperature, thus becomes

$$dn/dt = (n/N)\, dN/dt - \alpha_0 n^2 \exp(-ft), \qquad (8)$$

where $\alpha_0 = aT_m^{1/2}$. The above equation on simple quadrature becomes

$$1/n = \{\alpha_0/2f(g+\tfrac{1}{2})\}\{1 - \exp(-ft)\} + C_2. \qquad (9)$$

The accompanying figure shows $1/n$ versus time (Eastern Standard Time) for one day in August 1947 at Washington, D.C.[6]. The value of n was computed from the familiar expression $n = Kf^2$ for each half-hour interval. Upon the graph is indicated the decrease of electron concentration expected from equation (2), and that anticipated by employing equation (9). It is evident that the rate of change of electron population is very much better described



Comparison of $1/n$ determined from experimental evidence, from $1/n = \alpha t + C_1$ and from $1/n = \{\alpha_0/2f(g+\frac{1}{2})\}\{1 - \exp(-ft)\} + C_2$. (August 1947. F_2-region ionization) by the latter relationship, which contains the influx term, than by the former.

Since the temperature at the height of the E-layer was considered to have a negligible diurnal temperature variation, the relationships derived above degenerate to the conditions usually assumed for the E-ionospheric layer.

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[1] Woolley, R. van D. R., *Proc. Roy. Soc.*, A, **187**, 403 (1946).

[2] Jouaust, O. R., "L'Ionosphere" (Paris, 1946).

[3] Chapman, S., *Proc. Phys. Soc.*, **43**, 26 (1931); **43**, 483 (1931).

[4] Godfrey, G. H., and Price, W. L., *Proc. Roy. Soc.*, A, **163**, 228 (1937).

[5] Loeb, L. B., "Fundamental Processes of Electrical Discharge in Gases", 156 (J. Wiley and Sons, New York, 1939).

[6] U.S. Nat. Bur. Stand., *CRPL F*-30, 32; *CRPL F*-37, 28 (1947).

Uncertainty Principle

WRITERS appear either to introduce or to illustrate the uncertainty principle by supposing that a fundamental particle such as an electron is viewed through a microscope to determine its position at the same time as measurement is being made of its momentum[1]. The error in the position of the particle is accepted to be δx in the formula for the resolution power of a microscope, namely, $\delta x \sim \lambda/\sin\theta$. This formula is derived in optics from a study of the diffraction of light from two equal disks placed close together and from one disk alone.

Now the diffraction ring patterns of the disks are brought about, according to the quantum theory itself, by the action of quanta in the mass, and each individual quantum merely energizes a particular spot in a pattern. I cannot see that the optics formula, which essentially gives the effect of the mass action, can be applied to the action of an isolated quantum or photon. The appearance of a single photon on a screen cannot furnish any information about the direction from which it came before striking the screen, and even less can it indicate the point from which it emanated. If, as we are told, the wave phenomenon of light is due to mass action of photons, then we require proof that the wave formula can be applied to an individual photon, because we know that the behaviour of a single molecule of a gas is different from the mass behaviour of molecules producing sound in a gas.

A second difficulty is that the optics formula does not so much give a fundamental limit to observation, but rather a formula of convenience. It implies that it is difficult for the unaided eye to differentiate between the two sets of ring patterns, but it makes no claim that no difference exists between the patterns. The analysis admits that the set from one disk alone is circular, whereas that from two disks close together is oval. The formula gives the condition that the inner rings from the two disks change over from dumb-bell shapes which can readily be associated with two disks, to approximately elliptical ovals which cannot. By employing accurate methods for measuring shape and the intensity distributions in the fields, we can proceed considerably beyond the limit represented by the formula. An astronomer, for example, is justified in deducing that a star is a double star if the ring pattern he obtains from it is oval.

Perhaps the quantum theory can put this matter right, but I find the classical arguments so full of gaps that they are far from convincing.

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[1] For example, Gurney, "Elementary Quantum Mechanics", p. 49. Dustman, "Elements of Quantum Mechanics", p. 12. Heisenberg. "The Physical Principles of the Quantum Theory", p. 15 (German).

Early Man and Fossil Vertebrates on the Island of Celebes

OUTSIDE Java, which has yielded many important finds of fossil remains from the *Pithecanthropus* group of mankind and an abundance of fossil vertebrates, as well as two distinct palæolithic industries (the Patjitan chopper chopping-tool complex with an intrusion of 7 per cent Acheul hand-axes, and the Sangiran flake industry), palæolithic finds have not hitherto been made in the Indonesian Archipelago.

Prehistorical research on Celebes has now shown, however, that early man inhabited this island in Pleistocene times, since palæolithic tools have been discovered, associated with fossil bones of vertebrates of Asiatic origin. The newly discovered site is situated in the southern part of the island near Tjabenge and is bordered by the Walanae River on one side and by the Great Sinkang depression on the other.

Dr. D. A. Hooijer, of the Rijksmuseum van Natuurlijke Historie at Leyden, has studied the fossil fauna and has distinguished among the small collection five different forms, of which three are extinct: (1) a new genus of a large pig, *Celebochœrus heekereni* Hooijer[1]; (2) a dwarf archidiskodont elephant which is very closely related to the Lower Pleistocene *Archidiskodon planifrons* (F. and C.) from India and China[2]; (3) a large tortoise, *Testudo margæ* Hooijer[3]. The other two fossils are *Anoa depressicornis* (Smith) subsp. and *Babyrousa babyrussa beruensis* Hooijer[4], which are two typical elements from the recent fauna of Celebes, thus proving that those mammals had already evolved in Pleistocene times.

Celebes was, perhaps, never connected with Java (and Borneo), as the islands are separated by the deep Strait of Macassar and the Flores Sea. This is the so-called 'Wallace's Line', which indicates a faunal break between the Indo-Malayan and the Australian fauna (1860). This theory was at first generally accepted by zoologists; but now it is known that 'Wallace's Line', which was geologically well founded, separates a zone with rich animal life from a badly impoverished one, as Ernst Mayr has rightly pointed out. Migration to Celebes took place via land-bridges, which connected this island with the Philippines, Formosa and southern China. The newly discovered palæolithic industry is very closely related to the Sangiran flake industry.

Systematic research in this part of Celebes will no doubt lead to other important finds.

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[1] *Proc. Kon. Ned. Akad. Wet. Amsterdam*, **51**, 1024 (1948).

[2] *Zoo. Med. Rijksmus. Nat. Hist. Leiden* (in the press).

[3] *Proc. Kon. Ned. Akad. Wet. Amsterdam*, **51**, 1169 (1948).

[4] *Proc. Kon. Ned. Akad. Wet. Amsterdam*, **51**, 1322 (1948).

INTERNATIONAL RADIO CONFERENCES

DURING the summer of 1948 there were a number of international meetings in Europe on various aspects of radio research, development and operation. Three of these were held in Stockholm during July, while some of the others took place in Brussels, Copenhagen and London (see *Nature*, **161**, 695; 1948).

The International Scientific Radio Union (U.R.S.I.) held its Eighth General Assembly in Stockholm during July 13–24. Beginning concurrently with this meeting, the Fifth Reunion of the International Consultative Committee on Radiocommunication (C.C.I.R.) was also held in Stockholm. On the termination of the U.R.S.I., a brief meeting of the Joint Commission on Radio-Meteorology was held in the same place. Later, in Brussels, during July 28–30, there was a meeting of the Mixed Commission on the Ionosphere. At all these meetings the subjects discussed included various scientific and technical matters on which international collaboration or agreement is necessary in order to advance our knowledge of radio science and its application to radio communication, broadcasting and navigation. The above meetings were followed by a British Commonwealth Specialist Conference on Radio Research held in London during August 4–6. This formed a very convenient occasion to review the various recommendations made by the international assemblies, and to agree on an appropriate distribution of responsibility, within the Commonwealth, of the British contribution to the international research programme.

Wave-lengths for Broadcasting

Reference has already been made in *Nature* (**162**, 562; 1948) to the European Broadcasting Conference in Copenhagen, where over a period of some ten weeks a new plan was produced for a revised allocation of wave-lengths to broadcasting stations in Europe. The Copenhagen plan, 1948, as it is called, will come into operation on March 15, 1950, when some 340 stations and synchronized networks will be accommodated in 139 channels in the long (frequencies 150–285 kc./s.) and medium (525–1,605 kc./s.) wave portions of the radio spectrum allotted exclusively for broadcasting. Details of the new wave-lengths, with the frequency and power assigned to each station, are given in the *Wireless World* of November 1948.

Resolutions of the U.R.S.I. and C.C.I.R.

Reverting to the two major conferences, which are concerned with scientific research and development, some brief details of the resolutions and recommendations of the U.R.S.I. and C.C.I.R. are given below. The International Scientific Radio Union, the president of which is Sir Edward Appleton, after considering the extension of the radio field, decided to replace the four commissions, into which it was previously organised, by seven commissions. The titles and presidents of these are as follows: (I) Measurements and Standardization, Dr. J. H. Dellinger (U.S.A.); (II) Troposphere and Wave Propagation, Dr. C. R. Burrows (U.S.A.); (III) Ionosphere and Wave Propagation, Sir Edward Appleton (Great Britain); (IV) Terrestrial Atmospherics, Prof. H. Norinder (Sweden); (V) Extra-terrestrial Radio Noise, Dr. D. F. Martyn (Australia); (VI) Waves and Oscillations, Prof. B. van der Pol (Netherlands); (VII) Electronics, Dr. G. Lehmann (France).

The C.C.I.R. conference was held under the presidency of Dr. H. Sterky, director-general of telegraphs in Sweden, and was attended by delegates from more than thirty nations. A large proportion of its work at Stockholm consisted in surveying a number of technical questions put forward by the Atlantic City meeting of the International Telecommunications Union. Only a preliminary examination of these subjects could be carried out in most cases; and at the termination of the meeting, the plenary assembly of the C.C.I.R. set up thirteen international study groups to carry out preparatory surveys and submit reports for the next reunion, which is to take place in 1951. The subjects for study included various aspects of radio transmitters and receivers, wave propagation along the ground and through the lower and upper atmosphere, time signals and standard frequencies, and certain questions relating to broadcasting and television. During the Stockholm meetings, recommendations were made that Prof. B. van der Pol, of the Netherlands, should be appointed director, and Mr. L. W. Hayes, of the British Broadcasting Corporation, vice-director, of the C.C.I.R. Both appointments were to be taken up in January 1949.

Some of the conclusions and resolutions on scientific matters reached by the various conferences are referred to briefly in the following sections.

Radio Standards and Measurements

It was strongly recommended by the U.R.S.I. and the C.C.I.R. that the study of field-strength measurement over the whole frequency spectrum should be continued, and that the interchange of equipment between the various national laboratories should be encouraged. In addition, the U.R.S.I. urged that a study of standard noise sources of various types should be carried out, and that investigations should be made of the various methods of measuring radio-frequency power, particularly at frequencies above a few hundred megacycles per second.

On the question of standard frequency transmissions, the C.C.I.R. stated that there is an urgent need to put into operation additional standard frequency and time stations, perhaps in the United Kingdom and in Australia, to serve the now inadequately served areas of the world. Such stations should operate on the frequencies assigned for the purpose at the Atlantic City Conference in 1947, and it was recommended that an international study group should organise and control experiments to determine the effective service areas and the zones of interference with the existing emissions from Washington (Station *WWV*).

The Commonwealth Conference urged that the plans for the establishment of a standard frequency service in the United Kingdom should be pursued, and that both Australia and South Africa should establish similar services, if possible.

A further recommendation of some interest is that all standard-frequency stations should periodically and simultaneously interrupt their transmissions to permit measurement of natural radio noise, suitable programmes for this purpose to be worked out jointly by the U.R.S.I. and C.C.I.R.

Radio Wave Propagation

The subject of wave propagation was of common interest to all the international bodies, although perhaps with different objects in view; the following recommendations may therefore be taken as being agreed generally by the various organisations concerned.

(*a*) *Propagation through the ionosphere.* In order to assist the study of the characteristics of the ionosphere, and the presentation of the results of ionospheric soundings, a detailed list of symbols and related nomenclature was drawn up and recommended for general adoption. Various details in the technique of carrying out vertical incidence soundings were revised in order to secure uniformity in practice at ionospheric observatories. There was general agreement that the density of ionospheric recording stations over the world should be increased, particularly along the three lines of longitude, 150° E., 20° E. and 70° W.

The Brussels meeting of the Mixed Commission on the Ionosphere was presided over by Sir Edward Appleton, and in the course of its six sessions it surveyed in some detail our present knowledge of the ionosphere as obtained by direct radio exploration, and also by studies of auroras and geomagnetic phenomena. A number of resolutions were drawn up for consideration by the appropriate international scientific unions, with the view of enhancing the correlation of the characteristics of the ionosphere with geophysical and astrophysical phenomena.

At all the conferences there was universal agreement on the need for encouraging theoretical and experimental research on the mode of propagation of radio waves through the ionosphere, involving an increased and more precise knowledge of the absorption in the various regions, which is essential to the success of the forecasting of communication conditions. Particular attention was directed to the need for studying the technique of obtaining warning of disturbed conditions in the ionosphere, and communicating this to the practical user.

(*b*) *Propagation through the troposphere.* There was complete agreement at the Stockholm and London Conferences that it was necessary to proceed as rapidly as possible with the study of the propagation of waves at all frequencies above 30 Mc./s., in order to ensure the best and most efficient use of this end of the radio-frequency spectrum. At the lower end of this range, it is sometimes necessary to take ionospheric conditions into account; but in general at these frequencies, it is the propagation of such waves over the ground and the obstacles on it, and through the lower atmosphere, that is much more important in connexion with the practical applications of very short waves. It was recommended that simultaneous studies of radio-wave propagation and the associated meteorological conditions should be undertaken on as wide a basis as possible, and that the appropriate scientific radio and meteorological organisations should study the relevant characteristics of the troposphere in all parts of the world. In this connexion the need was expressed for improved techniques for measuring the vertical and horizontal gradients of temperature and humidity in the lower atmosphere, and the variations of these gradients with time and place. It was considered that the time is approaching when a suitable standard nomenclature might be drawn up for this subject, together with a uniform method of presenting both the radio and meteorological results.

These general recommendations were confirmed and elaborated by the Stockholm meeting of the Joint Commission on Radio-Meteorology, which held two technical sessions under the presidency of Dr. C. R. Burrows, of Cornell University. It was agreed that this Commission should direct its attention, as opportunity arose, to the theoretical and experimental determination of those properties of the lower atmosphere which affect radio propagation. These were deemed to include the study of storm detection by radar, and the location of sources of atmospherics by radio methods, as well as the actual transmission of radio-waves for communication or other purposes.

(*c*) *Long-wave propagation.* Following the lead given by the international bodies, the London Conference recommended that those Commonwealth countries in a position to do so should carry out a study of long waves propagated along the ground and through the ionosphere, and should seek the co-operation of other members of the Commonwealth when necessary. Partly in this connexion, it was considered important to increase our knowledge of the electrical constants of the ground, and all Commonwealth countries were urged to collect all appropriate information on this subject and arrange for its adequate distribution; and the United Kingdom was asked to prepare a survey of existing knowledge of the electrical constants of the ground at radio frequencies.

Radio Noise

In addition to the remarks already made above on this subject, the C.C.I.R. considered that atmospheric radio noise imposes one of the most important limitations on communications, and that therefore the study of such noise should be pursued on as wide a basis as possible. The conclusions agreed with those of the other bodies in recommending that meteorological studies should be undertaken to provide a knowledge of the distribution and nature of thunderstorms and the atmospherics originating from them. Investigations of the propagation of atmospheric disturbances and of the wave-forms and magnitude of the radio noise should be made in association with measurements of the direction of arrival at the receiver. Attention should also be given to the measurement of noise characteristics and their effects on receiving equipment in the frequency-range 10 kc./s. to 30 Mc./s., with particular reference to the range 10–300 kc./s.

The Commonwealth Conference endorsed the above recommendations and agreed to support the United Kingdom in the continuation and extension of a world survey of atmospheric noise-level by a subjective measuring method until the technique can be improved. It was further suggested that, in the interests of saving man-power and of ensuring that the quality of the data be as good as possible, particular consideration should be given by the United Kingdom to restricting the time schedule of such observations to the minimum necessary to obtain an adequate representative sample.

All meetings agreed that the work at present being conducted on solar and cosmic noise in various countries should continue on the existing lines.

Conclusion

The above notes are intended as only a general survey of the main conclusions of the conferences, and a more detailed consideration of the various recommendations must await the publication of the proceedings of the meetings in the usual manner. Apart from the actual committee work leading to these results, the various conferences provided the usual informal opportunities for meeting contemporary workers in other countries. The meetings in Sweden also enabled delegates to visit certain research and manufacturing organisations in Stockholm and Gothenburg. R. L. SMITH-ROSE

LARGE-SCALE VERTICAL MOTION IN THE ATMOSPHERE

AT a meeting of the Royal Meteorological Society on February 16, the subject for discussion was large-scale vertical atmospheric motion. In opening, Mr. J. K. Bannon stressed the importance of the rising and sinking of large masses of air in atmospheric dynamics and explained the relatively small attention given to vertical motion by meteorologists by the fact that so far it has been impossible to measure directly the vertical velocities, which can only be inferred, and that with difficulty. He went on to describe a method of estimating up-currents from the rate of rainfall[1], depending on the approximate equality of the rate of release of precipitation from a mass of rising air and the rate at which the saturation vapour content of the same air decreases as the temperature falls due to adiabatic expansion (that is, neglecting the changing water content of the cloud particles, which is small except in convection clouds). This method can be applied in cases of steady rising currents over a wide area (thirty miles square or more), and examples of results obtained from rainfall records in the Hebrides show that up-currents in the lower and middle troposphere are of the order of 10–20 cm./sec. in typical disturbances of the North Atlantic.

Mr. J. S. Sawyer then gave a brief description of two other methods of deducing vertical atmospheric movement. The first, that of Graham[2], requires a network of upper air observations of temperature and wind at regular time intervals. The horizontal motion between consecutive times of upper air observations being known, temperature changes unexplained by horizontal movement are assumed to be due to changes in height, and to take place adiabatically; and hence the vertical motion in the period may be inferred. The method is quick and may be used by the weather forecaster; the results are consistent with other phenomena such as rain (up currents). The second method, which Mr. Sawyer has applied to several cases in the neighbourhood of the British Isles, depends on the relation between vertical motion and the divergence of the horizontal wind field (the equation of continuity), and between the divergence of the horizontal wind field and the rate of change of the vertical component of vorticity (the vorticity equation). Several approximations must be made, but even so the technique is rather laborious and the method is only suited to research. Notwithstanding the approximations, the results obtained agree qualitatively with expectations, up-currents being deduced over rain areas and down-currents over anticyclones; Graham's method gave comparable results. As emphasized later in the discussion by Dr. R. C. Sutcliffe, this vorticity method requires only knowledge of the pressure field—at more than one level, of course—and can be employed when wind observations are lacking.

Prof. P. A. Sheppard then gave a preliminary account of work being carried out under him in the Department of Meteorology of the Imperial College of Science and Technology by Mr. H. A. G. van Ufford and others. The eight radar wind-finding stations in the British Isles may be grouped to form seven triangles with sides of the order of 200–300 miles in length. The wind observations at the corners of these triangles (specially supplied by the Director, Meteorological Office, to the nearest degree in direction and the nearest knot in speed) were used to evaluate the horizontal divergence over each triangle, at 100 mb. intervals, between pressure-levels of 900 mb. and 200 mb., that is, approximately between 3,000 and 40,000 ft.; by the equation of continuity the vertical motion at each level was deduced from the horizontal divergence. The months December 1947–February 1948, inclusive, were investigated, and the large amount of data so obtained is still being analysed.

A few examples of results obtained were given. The weather of December 1947 was mainly anticyclonic over southern England, that of January 1948 very disturbed and cyclonic; frequency curves of the distribution of ρw (where ρ is air density, w is vertical velocity) for both the lower and upper troposphere reflect this, showing a preponderance of down-currents in the south of the British Isles in the first month; in the January, both in the north and the south of the country, almost equal numbers of up and down currents occurred, and larger vertical velocities were more frequent. Prof. Sheppard also demonstrated curves showing the distribution with height of the mean up and down velocities for January 1948 over central England. When there was general ascent below 500 mb. the maximum of just over 7 cm./sec. occurred between 600 and 500 mb., that is, about 16,000 ft.; with general subsidence in the troposphere, the maximum was between 6 and 7 cm./sec. and occurred between 500 and 400 mb. (about 20,000 ft.). It is noteworthy, he said, that in both cases the mean up and down currents, respectively, at tropopause-level are about 4 cm./sec. As well as the statistical results, which Prof. Sheppard stressed were the most important and significant outcome of the investigation, the distribution of vertical velocity was demonstrated for a few individual occasions, agreeing well with the general features of the weather (rainfall, development of ridges of high pressure, etc.). Velocities, both up and down, of up to 30–40 cm./sec. were deduced even in the lower stratosphere, though 10–20 cm./sec. were more usual maxima.

Mr. M. K. Miles said that, in using Graham's simple method, it is necessary to remember its limitations; as the author admits, it does not always lead to one definite value of vertical motion, and also the deduced velocity is an average over a considerable time, usually 6–12 hours. A comparison with Bannon's method, which tends to under-estimate the up current, and with a direct evaluation from horizontal wind observations, in one particular case, showed that Graham's method considerably under-estimates the vertical velocity.

Dr. R. C. Sutcliffe was enthusiastic of the results obtained so far by Prof. Sheppard. The network of upper air observing stations in the British Isles is the closest in the world, and this region should be used to determine the basic facts of the structure and working of typical weather situations. Atmospheric models, so determined, may then be applied to similar phenomena in other parts of the world where upper air information is scanty or lacking. Prof. Sheppard's investigation is an example of the use to which the British Isles observations may be put, to the great benefit of meteorology generally. Dr. Sutcliffe also pointed out that the horizontal scale of these vertical currents deduced by Prof. Sheppard is implicit in the dimensions of the triangles of observations used.

In reply to questions from Mr. C. S. Durst, Prof. Sheppard said that he had found no individual cases giving ridiculous values for the vertical velocities; since the radar wind observations are averages over depths of about 3,000 ft., such small variations in the wind as Richardson[3] feared would preclude any attempt at a numerical analysis of the wind field of a weather situation are probably eliminated. The time required to analyse each wind-finding ascent for all the various levels is about half an hour, using graphical methods. This indicates the large amount of work involved in producing the basic data for his investigation.

In concluding the discussion, the president, Sir Robert Watson-Watt, said that the results described showed exciting progress; as that most famous English meteorologist, Sir Napier Shaw, used to emphasize, measurements are as essential in meteorology as in every other branch of science.

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[1] Bannon, J. K., *Quart. J. Roy. Met. Soc.*, **74**, 57 (1948).

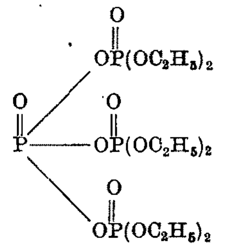
[2] Graham, R. C., *Quart. J. Roy. Met. Soc.*, **73**, 407 (1947).

[3] Richardson, L. F., "Weather Prediction by Numerical Process" (Camb. Univ. Press, 1922).

INSECTICIDAL PROPERTIES OF CERTAIN ORGANO-PHOSPHORUS COMPOUNDS

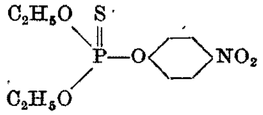
THE success of D.D.T. and benzene hexachloride insecticides has already shown the important part that synthetic chemicals can play in agriculture. Interest is therefore being shown in the organo-phosphorus group of insecticides, especially as certain of these compounds show high contact-activity and others are capable of rendering the plant systemically insecticidal. As these compounds have not yet been available in sufficient amounts for wide-scale investigations, and as little has been published on the subject, there is a considerable demand for accurate information. A meeting of the Association of Applied Biologists on November 5 sought to adjust this state of affairs by bringing together workers qualified to speak on various aspects of the subject.

Dr. H. Martin, of Long Ashton Research Station, introduced the proceedings. He referred to the classical work of Michaelis (1890–1915) on the chemistry of the organic compounds of phosphorus, and mentioned that Nylen[1] had described the tetraethyl ester of pyrophosphoric acid but had overlooked its toxicity towards insects. The discovery of, and information on, the insecticidal properties of these compounds was due almost entirely to Schrader[2]. He had shown that tetraethyl pyrophosphate is highly toxic to aphides, but had not carried forward his discovery to the manufacturing scale, as the substance rapidly lost its activity in contact with water. Instead, Schrader had investigated the reaction between phosphoryl chloride and triethyl phosphate and had obtained a product known as hexaethyl tetraphosphate (I), which he considered had the following structure:



(I)

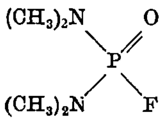
This substance was shown to be as toxic to aphides as nicotine and to have sufficient water-stability to be of practical value; consequently, its manufacture was commenced in Germany in 1944. Dr. Martin mentioned that chemical evidence had recently been produced that hexaethyl tetraphosphate is probably a mixture of alkyl polyphosphates; but investigations at Long Ashton on the toxicity of samples prepared by different processes had revealed no differences. However, it is not sufficiently stable for use with alkaline spray material such as lime sulphur or for incorporation in dusts, consequently its usefulness to agriculture is limited. Schrader found that the thiopyrophosphoric esters were more stable to hydrolysis than the pyrophosphoric esters, yet retained their pronounced insecticidal action. In 1945 a series of thiophosphoric acid derivatives was investigated, with the result that the highly potent insecticide, diethyl-*p*-nitrophenyl thiophosphate *E*.605 (II), was discovered.



(II)

E.605 was a marked improvement on hexaethyl tetraphosphate. It is more toxic to many species of aphides than nicotine, giving a complete kill at 0·005 per cent (Schrader), and is sufficiently resistant to hydrolysis to be used with lime sulphur or as a dust. It is also ovicidal, being about as toxic to *Aphis pomi* eggs as 3 : 5-dinitro-*o*-cresol. Claims had been made that *E*.605 was toxic to a wide range of insects. Schrader found that diethyl-*p*-nitrophenyl phosphate (*E*.600) was also highly insecticidal, but had not gone further with this compound on account of its toxicity to mammals.

Dr. Martin then referred to the discovery of the systemic insecticides by Schrader and Kükenthal[3]. Apparently these workers had included a soil-watering test in their routine examination for insecticidal properties, and had found that certain organic compounds could be absorbed by plants, which thereby became toxic to insects placed on them. Few of the systemic insecticides described by Schrader are available in Great Britain, but three have been examined at Long Ashton:

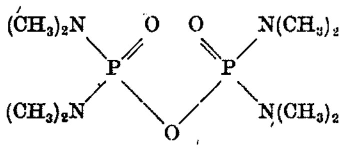


(III)

Bis-(dimethylamino)fluoro-phosphine oxide

$CH_2(OCH_2CH_2F)_2$ (IV)

Bis-(2-fluoroethoxy)methane



(V)

Pyrophosphoryl tetrakis dimethylamide

Dr. Martin considered that the systemic insecticides would prove of value in the investigation of translocation in plants, but he deprecated their practical use for insect control before it is known whether or not they are toxic to mammals or give rise to toxic products in the plant.

Dr. H. E. Coates discussed points of chemical interest concerning the phosphorus insecticides, particularly methods of synthesis and questions of chemical constitution. He said that hexaethyl tetraphosphate is a mixture of linear polyphosphoric esters, hexaethyl tetraphosphate, pentaethyl triphosphate, tetraethyl pyrophosphate and unreacted triethyl phosphate, together with a small amount of acidic by-product. The branched structure (I) suggested by Schrader is incorrect because only a small amount of *ortho*-phosphoric acid is obtained on hydrolysis, whereas the branched formula should give one molecule of *ortho*-phosphoric acid per molecule of the substance. The explanation of linear ester formation is that phosphoryl chloride and triethyl phosphate disproportionate on heating to give a mixture of diethyl chlorophosphonate and ethyl dichlorophosphonite, which then reacts with more triethyl phosphate to give the linear esters. Two methods for the preparation of tetraethyl pyrophosphate were given; the first, of academic interest only, uses silver pyrophosphate and ethyl iodide, but the second, from diethyl chlorophosphonate and triethyl phosphate, is applicable to large-scale production. *E*.605 can be prepared by allowing thiophosphonyl chloride to react with alcoholic sodium ethoxide, the resulting diethyl chlorothiophosphonate being heated with sodium *p*-nitrophenate in chlorobenzene. In the synthesis of bis-(dimethylamino)fluorophosphine oxide, it was shown to be advantageous to cause one molecule of phosphoryl chloride to react with four molecules of dimethylamine to give bis-(dimethylamino)phosphoryl chloride $[(CH_3)_2N]_2POCl$; this gave the desired end-product on reaction with sodium fluoride. Reference was made to a recent colorimetric method[3] for the estimation of *E*.605.

Mr. S. H. Bennett described preliminary experiments with systemic insecticides, referring to certain organo-phosphorus compounds, and to bis-(2-fluoroethoxy)methane, which had been investigated by Schrader, and also to sodium selenate, the systemic properties of which are more generally known. Schrader's findings had first been confirmed at Long Ashton when groundsel plants watered with a 1 per cent solution of bis-(2-fluoroethoxy)methane were shown to be highly poisonous to fully grown larvæ of the cinnabar moth (*Callimorpha jacobææ*). Similar results were obtained using tick bean plants inoculated with bean aphis (*Aphis fabæ*); infestations occurred only on untreated plants. It was found that bis-(dimethylamino)fluorophosphine oxide and bis-(2-fluoroethoxy)methane had powerful systemic properties, but pyrophosphoryl tetrakis dimethylamide was only weakly systemic. These compounds act as fumigants as well as contact poisons; but tests of the former activity failed at first because of the difficulty of separating the fumigant effect of the material in the leaf from that in the soil. This difficulty was overcome by rooting willow plants in water culture, transferring to the insecticide solution and returning to the water culture again when sufficient material had been absorbed, after which it was possible, by assuming uniform distribution of insecticide throughout the plant tissue, to calculate the amount present in a leaf. The fumigant effect was then tested by placing brassy willow beetles (*Phyllodecta vitellinæ*) on muslin with the plant material below and enclosing the whole in a glass vessel. In these circumstances it was found that the fumigant activity of the insecticide in the plant tissue was a hundred times as great as might have been expected from comparable experiments with aqueous solutions. Further experimental work is desirable to explain this effect, which may be the result of differences in the partial pressure of the fumigant in the two systems.

In further experiments, *Calandra granaria* were fed on grain from plants which had been watered with solutions of bis-(2-fluoroethoxy)methane or sodium selenate. While neither compounds caused the grain to become directly toxic to the weevil, infestation did not build up in the selenate-treated wheat, and it appeared that the reproductive powers of the insect had been affected. Referring to the phytotoxicity of these compounds, Mr. Bennett mentioned that bis-(dimethylamino)fluorophosphine oxide is the most toxic to plants growing in soil, but in water culture pyrophosphoryl tetrakis dimethylamide has caused serious plant damage.

In the general discussion that followed, Dr. J. K. Eaton referred to the ovicidal properties of *E*.605 and related compounds. He said that, of the twenty-seven substances examined at East Malling, only *E*.605 and *E*.600 (diethyl-*p*-nitrophenyl phosphate) showed appreciable toxicity to winter moth eggs (*Operophtera brumata*). The eggs of the green apple aphis (*Aphis pomi*) were more susceptible to the action of these organo-phosphorus esters, *E*.600 and di*iso*propyl-*p*-nitrophenyl phosphate giving complete kill at 0·005 per cent. The results indicated that toxicity to *Aphis pomi* eggs is associated with the incorporation into the phosphoric or thiophosphoric acid molecule of two alkyl groups and an aryl group. Toxicity is increased by the introduction of electron-attracting groups in the *para* position of the aryl substitutent. Preliminary field trials for the control of certain species of aphides using *E*.605 and hexaethyl tetraphosphate had been carried out. The results showed that both give control equal to or better than nicotine at the same concentration; *E*.605 is generally the superior. No phytotoxic effects had been noted.

Mr. R. S. Pitcher said that a high kill of the raspberry cane midge (*Thomasiniana theobaldi*) had been obtained under conditions in which *E*.605 appeared to exert an ovicidal effect at a distance. Dr. Martin replied that there was little evidence that *E*.605 had systemic properties, and he considered that the action could be explained as a fumigant effect. Answering a question concerning the use of systemic insecticides marked with radiophosphorus for following the movement of these compounds in plants, Dr. B. A. Kilby said that work had just started at the University of Leeds on the synthesis of such compounds. The most convenient synthesis used phosphoryl chloride as the starting material[1]; but radiophosphorus is most readily available as inorganic phosphate, and the conversion of this to phosphoryl chloride is not easy. The difficulty might be overcome by the discovery of a suitable exchange reaction or by a supply of radiophosphorus in a more convenient form.

Dr. R. A. E. Galley urged that the nomenclature of the organo-phosphorus compounds should be standardized and favoured the introduction of trivial names for the better known phosphorus insecticides.

J. K. EATON

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[1] *Z. anorg. Chem.*, **212**, 182 (1933).

[2] *Brit. Intell. Obj. Sub-comm.*, Final Report 714 (1947).

[3] *Anal. Chem.*, **20**, 753 (1948).

'MECHANISM' OF *PHYTOPHTHORA*-RESISTANCE OF POTATOES

By K. O. MÜLLER and LOTHAR BEHR*

USING as a basis the American 'native forms' of the tuber-bearing species of Solanaceæ, German breeders during the last two decades have developed potato varieties with both leaves and tubers resistant to most of the known races of *Phytophthora infestans*. It is true that the origin and initial constitution of the material which was used for the breeding of these varieties is only imperfectly known; but we know that its refractory behaviour towards the *Phytophthora* fungus is associated with a gene *R* which is not found in any European variety of the old-fashioned type. Furthermore, according to K. O. Müller, this resistance gene has several associated alleles and is inherited independently of other economically important characters, such as yield capacity, time of maturity, and the like. Therefore it did not take very long to combine the *Phytophthora* resistance of these '*W* varieties' with the high yielding-capacity and other inherent qualities of the European cultivated potato. The first German commercial varieties resistant to *P. infestans* which appeared on the market were Erika (1941), Robusta (1941), Fruehnudel (1941), and Aquila (1942). There are at present in Germany ten new registered potato varieties, all of which possess this resistance gene.

Investigation into the mode of action of this gene, particularly as regards the tubers, led to the conclusion that the alleles present in the *W* varieties are not responsible for the resistant condition itself, but induce only a genetic predisposition of the tissues to 'acquire' a local immunity from infection when they come into contact with the hyphæ of parabiontic races of *P. infestans* (that is, those strains which kill the cells quickly, thereby arresting the further growth of the hyphæ). From the physiological point of view, whether or not a variety is resistant is not decided until the parasite has penetrated into the host tissues. Comparative investigations into the reactions of susceptible and resistant genotypes revealed that in both the host cell is destroyed after coming into contact with the protoplasm of the parasite. Judging by the morphological and physiological changes the final effect is the same—the cell collapses and loses its ability to serve the parasite as a host. But the rapidity with which this final effect is achieved differs in susceptible and resistant genotypes. While the cells of the former live relatively long —six to fourteen days at 19–21° C.—those of the latter die after one or two days, the process being too rapid for fructification of the fungus to occur; moreover, further penetration by the hyphæ is made impossible by the rapid reaction of the host tissue, which in the course of this reaction also loses its ability to serve as a host to eusymbiontic fungus strains (that is, strains which can invade the host tissue without killing it quickly). Other pathogenic micro-organisms, too, are unable to use such 'immunized' tissues as nutritive substrates. The reaction is therefore unspecific (K. O. Müller and H. Boerger).

Cytological-physiological investigations by K. O. Müller, G. Meyer and M. Klinkowski in 1938 showed that it is possible to distinguish in this 'defence-necrosis' at least five successive stages, the last two being characterized by cell collapse and by a heavy infiltration of the cell-walls and cytoplasm with phlobaphene-like compounds, which appear to arise, according to Meyer (1939), through polymerization of tannic substances. These can be demonstrated by the usual tannin reagents after infection in host cells which are still alive.

This close relation between the degree of resistance and the rapidity with which necrosis is brought about was demonstrated in extensive breeding material, consisting partly of previously unselected *F*2 families of crosses between 'resistants' and 'susceptibles'. It was also shown that the two extremes, 'highly susceptible' (the parasite penetrating uniformly through the entire tuber and fructifying luxuriantly) and 'highly resistant' (the parasite penetrating only a few cell-layers of the parenchyma of the tuber and then ceasing to grow without fructifying), are connected by at least two genotypically conditioned intermediate types. These are characterized by an intermediate reaction-rate and—in agreement with what has just been said—their tubers are penetrated to a considerable depth by the parasite (K. O. Müller).

Other investigations led to the conclusion that the 'defence necrosis' is induced by substances secreted by the parasite into the host tissue. Accordingly, the specific behaviour of the resistant genotypes would appear to depend on a specific sensitivity of the protoplasm, controlled by gene *R*, so that the highest reaction-rate would be associated with the greatest degree of resistance. Because the susceptible genotypes also react to these substances, there appears to be no fundamental, but only a graduated, difference between 'resistants' and 'susceptibles', and we conclude (paradoxical though it may appear at first) that the greater the sensitivity of the cells to the metabolic products of the parasite, the greater the resistance of the tuber. Further, the resistance gene *R* is not a factor *sui generis*; it only accelerates a reaction which the susceptible genotypes are also capable of producing. There is, however, a further conclusion. In the course of the reaction the host tissue loses the ability to serve as a nutrient substrate for the fungus. As not only *P. infestans*, but also other micro-organisms which can thrive on a wide range of organic matter (*Rhizopus nigricans*, *Aspergillus niger*, and others), are not able to exist in the necrotic, transformed tissue, the necrosis of the affected tissues must be accompanied by the formation or activation of a principle ('phytoalexin') which exercises a retarding influence on the penetrating parasite. In these circumstances necrosis would depend less on the absolute reaction-rate and more on the relation between the hyphal growth-rate (Cp) and the rapidity with which the principle forms (Cw). Hence with increasing $Cp : Cw$ values the resistance would decrease, while with decreasing values it would increase.

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From experiments in which the influence of temperature on the reaction in various genotypes was examined, valuable insight was obtained into the dynamics of the defence mechanism described above (K. O. Müller and R. Griesinger). At low temperatures (5–10° C.) the immunological behaviour of the susceptible genotypes strongly resembled that of the resistant ones. But on the other hand, no decrease in the capacity for resistance in the resistant genotypes was induced. This, however, was achieved in another way, and for this K. O. Müller and L. Behr started from the following hypothesis. If it were possible in the resistant genotypes to retard the necrosis of the tissues affected by the fungus by some kind of chemical or physical treatment of the tubers, the development of the fungus would be promoted simultaneously. The parasite would be able to penetrate farther into the tissues than in the untreated tubers, and at the same time would also fructify.

The experience of other workers (Salmon, Stakman, Bolle, Gassner and Hassebrauck), who have studied the effect of narcotics on the immunological behaviour of plants against fungal parasites, suggested the materials to use for such experiments. The tubers of resistant and susceptible genotypes were treated with methyl, ethyl, propyl, butyl, *iso*propyl, and *iso*butyl alcohol (water–alcohol mixtures), and were inoculated *after* treatment. Germination tests with sporangia of *P. infestans* in alcohol–water mixtures showed that the concentrations used did not check the development of the parasite. The results were as anticipated. The treatment of the tubers with the alcohols above mentioned prolonged considerably the life of the cells which had come into contact with the parabiontic strain of *P. infestans* (retardation of cell collapse, inhibition of phlobaphene formation). At the same time—and this is most important—a material increase in the development of the fungus followed, which in many cases went so far that the parasite developed thick aerial mycelium (with sporangia), even in the highly resistant types.

The accompanying table shows the effect of ethyl alcohol on the immunological behaviour of a highly resistant *W* variety.

That the tubers were *in toto* still alive after the alcohol treatment was shown by the ability of parenchyma cells to become plasmolysed and by the fact that non-inoculated tubers, treated with a 3–5 per cent alcohol–water mixture, could be stored for weeks at room temperature and high air humidity without showing any rotting symptoms caused by facultative parasites.

A comparison of the effects of the four normal alcohols showed that a close correlation exists between the length of the carbon chains and their effect in reducing resistance. Richardson's 'law of homologous series' has thus been confirmed. Furthermore, *iso*propyl and *iso*butyl alcohol were considerably less effective than the normal alcohols. This result, too, agrees with the findings of previous workers, who maintained that the greater the branching of the carbon chains, the less the narcotic effect.

Effect of ethyl alcohol on the immunological behaviour of the *W* variety *BRA* 23/31

Concentration of alcohol (% volume)	Reaction of the host			Development of the parasite	
	Necrotic changes immediately beneath the site of inoculation		Phlobaphene-formation within the tuber	Aerial mycelium (sporangia)	Within the tuber
	after 48 hours	after 120 hours	after 120 hours	after 120 hours	after 120 hours
0 (Control)	very strong	very strong	very strong, distinctly limited (2–3 cell-layers)	none	no mycelium outside the necrotic tissues
3	weak	strong	weak, diffuse, up to a depth of about 10 mm.	thin	parasite penetrated up to about 35 cell-layers
5	weak	strong	,,	thin	,,
10	very weak	very strong	very weak (greatly variable in extent)	thick	penetration up to about 15 cell-layers
12	very weak	very strong	extremely weak, diffuse	very thin	penetration up to about 7 cell-layers

The results of these experiments with narcotics have thus confirmed the original theory developed on a genetic basis: the greater the rapidity with which the host cells in contact with the fungus react to the metabolic products excreted by the fungus, the greater the resistance of the plant. The results also suggested a satisfying physiological explanation of the effects of narcotics in decreasing resistance, noted already by previous workers on other organisms, though differently interpreted. Details cannot be given without exceeding the scope of this short article, but our interpretation appears to have the advantage of explaining satisfactorily many effects, with only one premise to be recognized, namely, the greater the reaction-rate, the greater the resistance.

The effect of chloroform (applied as a vapour) has also been tested, and the result agreed with the above findings. This leads to the conclusion that the action of narcotics on the 'resistance mechanism' is an effect connected with the primarily unspecific changes in the physico-chemical structure of the host cell. As other observations point to the fact that the necrobiosis is connected with the respiratory metabolism of the host cell, it can be assumed that it is this metabolism which the narcotics affect first. This would also hinder the course of the defence necrosis and simultaneously postpone the material changes in the host cell, which we must consider to be the direct physiological cause of the 'defence' against the parasite.

Whether or not this attempted explanation conforms with the facts, we can deduce from the results that the necrobiosis of host tissue, induced by a parabiontic strain of *P. infestans*, is essentially an active response of the affected cells, very probably connected with an increased release of energy. If the defence necrosis of the resistant genotypes induced by fungal contact were the same as a passive dying, such as we can observe, for example, after the effects of supramaximal or inframinimal temperatures, it would appear incomprehensible why just those substances, which in our experience had only a paralysing effect on cell activity, should increase the longevity of infected cells.

SEISMOLOGY IN BRITAIN

A VERY wide range of activity in the fields of pure and applied seismology by British seismologists is referred to in the recently published fifty-third report of the Committee on Seismological Investigations of the British Association for the Advancement of Science.

The work of the International Seismological Summary is carried out by a staff of three, headed by Mr. J. S. Hughes. Through the courtesy of the director of the Meteorological Office it is housed in two huts at Kew Observatory. The bound volumes for 1936 have been issued, as also have more recent quarterly parts. Manuscript for 1937 is compiled. The past year has seen the change-over from the use of normal geographic co-ordinates for the positions of observing stations as a basis for the estimate of travel times to that of geocentric direction-cosines. Such a change means that no distances, calculated for epicentres used before 1937, can be used for preliminary epicentres. The slowing up of the work, now that the system is well in hand, is thought, however, to be inappreciable. Prof. H. Jeffreys (director) and Mr. J. S. Hughes now wish to know what readings they may expect to receive from observatories for the period after the outbreak of hostilities in 1939.

There have been few British earthquakes recently. The earthquake of May 28, 1948, at 17h. 02½m., G.M.T., was felt over a considerable region of Norfolk, Suffolk and Cambridgeshire, but was accompanied by no appreciable damage. It was recorded by the Kew seismographs, both short-period and Galitzin, *Pg* occurring at 17h. 02m. 53s. G.M.T. and *Sg* 14 sec. later; the distance from Kew was therefore about 120 km. Dr. A. T. Dollar, of the University of Glasgow, has resumed the collection of macroseismic data concerning British earthquakes, and it is hoped to publish his collected observations on the small earthquakes of April 2, 1948, at Bethesda, Carnarvonshire, and May 31, 1948, at Ullapool, Ross-shire, together with later observations in 1949.

Phase	Velocity	Starting time	Thickness	Standard deviation of one observation
Sedimentary *P* wave	1·6 – 5·4 km./sec.	0	9·01 ± 1 km.	—
Pg (Near stations)	6·06 ± 0·09	2·8 ± 0·27	17·4 ± 2 km.	0·16 sec. on regional means
Pg (Distant stations)	4·9 – 5·5	—	—	3 sec. for 1 layer. 0·50 and 0·86 for 2 layers
Pn	8·18 ± 0·014	7·37 ± 0·1	—	0·19 sec.
Sn	4·36 ± 0·06	2·8 ± 1·3	—	0·43 sec.
R	3·05 ± 0·1	4·6 ± 6	—	3·6 sec.

Two of the Committee's seismographs were removed from the University Observatory, Oxford, to Down House, Downe, Kent, in 1937, and were put in the care of Dr. O. J. R. Howarth. They were assembled by Miss E. F. Bellamy and later calibrated by Mr. J. S. Hughes and Mr. E. N. Lawrence. Dr. Howarth has since been comparing the seismograms which he has obtained with the readings from the seismograms obtained at the observatories at Kew and Durham, and also with the preliminary epicentres on the cards issued by the United States Coast and Geodetic Survey; he has also sent observations on microseisms to Dr. G. E. R. Deacon at the Admiralty Research Laboratory. In addition, the Committee has Milne–Shaw seismographs at Edinburgh (recording suspended), Cape Town, Perth (Western Australia) and Suva (Fiji), and a Jagger shock recorder at Comrie, Perthshire.

The seismological work of the Department of Geodesy and Geophysics at the University of Cambridge has included Prof. E. R. Lapwood's theoretical investigation of the diffraction effects at the surface of a semi-infinite homogeneous elastic medium after a pulse has been emitted by a buried line source. Prof. Lapwood has shown that at distances large compared with the depth of the source, the disturbance at the time of arrival of the direct *S*-pulse differs from that at the time of arrival of the *P*-pulse in being smudged or blunted. Some seismic work at sea has been done; microseisms with frequencies greater than 8 cycles per sec. have been investigated and are thought to be man-made; and short-range explosion seismology has been done in the Lake District and in Wales. Mr. P. L. Willmore has designed a moving-coil seismograph with a nearly constant response to ground velocities of frequency 2–25 cycles per sec., and a maximum sensitivity of 5,000 cm. per cm. per sec. Mr. M. N. Hill has designed a long-period inductance-bridge seismograph. Mr. Willmore spent several months in Germany, arranging for seismological observations to be made on the tremors from the explosion on Heligoland of nearly 4,000 tons of ammunition on April 18, 1947. Observations were made by portable seismographs in Germany, chiefly from the Geophysical Institutes at Göttingen and Celle, in Holland and in Denmark, and by two ships in the North Sea. The tremors were also recorded by observatory seismographs in Belgium, France, England, Czechoslovakia and Switzerland. Travel times were observed at distances of 50–1,000 km. from Heligoland; these were supplemented by the observations up to 50 km. of the explosion of about 400 tons of explosive near Soltau in the autumn of 1946. The characteristics of the artificial earthquake wave phases are given in the table, which also includes figures for the thicknesses of the assumed layers.

R appears to be a wave, according to Willmore, which was propagated through the ultrabasic layer, after suffering reflexion from the surface at one point in its path. Prof. C. Charlier is of the opinion that this observed phase was propagated through a separate layer in the earth. Calculations from the measurement of seismograms give a value of 10^{17} ergs for the energy transformed into earthquake waves by the whole explosion. Measurements of the crater show that $1 \cdot 5 \times 10^{18}$ ergs were expended in moving the rock above the charge, while the total thermal energy of the explosive was $1 \cdot 3 \times 10^{20}$ ergs.

Dr. G. E. R. Deacon reports that work at the Admiralty Research Laboratory seems to throw some light on the origin of microseisms. It has been shown that pressure fluctuations due to sea-waves likely to be responsible for microseisms occur when there is interference between sea-wave groups of the same frequency travelling in opposite directions. This interference may arise in the neighbourhood of a fast-moving depression over the sea, or in a coastal region where energy is being reflected from the shore. The theory suggests a definite two to one relationship between the periods of the sea-waves and microseisms, which has been confirmed by observations. Further, by submitting simultaneous records of waves and microseisms to frequency analysis, it has been thought safe to conclude that a depression moving rapidly over deep water north of the Azores caused microseisms at Kew. Microseisms on Kew seismograms can be detected some thirty hours before the swell from a distant storm reaches the coast.

ERNEST TILLOTSON

MAGNETIC AMPLIFIERS

THE thermionic valve amplifier is so universal in its application that even the existence of other means of amplifying tends to be overlooked. Two papers read recently before the Institution of Electrical Engineers record developments in magnetic amplifiers, and indicate the field of application within which such amplifiers possess advantages. These papers, "Magnetic Amplifiers", by A. G. Milnes, and "A Theoretical and Experimental Study of the Series-Connected Magnetic Amplifier", by H. M. Gale and P. D. Atkinson, were presented on December 2, 1948.

Essentially the principle of the magnetic amplifier is that of controlling the current in an A.C. circuit by varying, by means of an auxiliary D.C. circuit, the impedance of an iron-cored reactor in series with the load. The D.C. circuit thus effects its control by producing magnetic saturation of the reactor core. This principle has been known and has been applied for many years, indeed since the period of the First World War; but it was not until high-permeability nickel–iron alloys and metal rectifiers became available that rapid development of the magnetic amplifier for a wide range of applications took place.

The basic circuit arrangements of magnetic amplifiers have now assumed fairly well established forms, and the present papers give a systematic theoretical treatment and design procedure for the standard circuits. As a rule the magnetic amplifier operates as a D.C. amplifier in the sense that the input or controlling current is a small direct current, and the output is again a direct current produced by the rectification of the alternating current passed by two reactors, the reactance of which is controlled by the input. A simple, single-stage magnetic amplifier employing high-permeability cores might give a power-gain of the order of 10 to 20. This gain may be very greatly increased, however, by the use of positive feed-back. Feed-back is applied by circulating the direct output current through an additional winding on the cores. If the magnetic effect of this feed-back winding is in such a direction as to reinforce that of the input current, there is partial self-excitation which increases the ratio of output current to input current. The effects of feed-back are closely analogous to those obtained with thermionic amplifiers, and excessive positive feed-back will give rise to instability. Positive feed-back is commonly utilized to obtain power gains per stage of the order of 2,000. Without feed-back a magnetic amplifier does not discriminate between positive and negative input signals; but with the application of feed-back, reversal of the polarizing flux changes the feed-back from positive to negative, and discrimination results. Magnetic amplifiers commonly operate with input powers of the order of a microwatt, and it is stated in one of the papers that 10^{-9} watt may be regarded as the lower usable limit of input power.

Perhaps the most significant difference between the behaviour of the magnetic amplifier and that of the thermionic amplifier lies in the time delay of the response of the magnetic amplifier to a sudden change of input. The build-up of the steady state following a sudden alteration of input is approximately exponential, and the response-time of magnetic amplifiers is usually expressed as the time-constant of an approximately equivalent exponential rise. This time delay, which is practically inversely proportional to the frequency of the A.C. supply and increases in proportion to the stage amplification, is one of the important limiting factors in the application of magnetic amplifiers. In order to obtain a high ratio of amplification to time-constant it is desirable to connect a number of stages in cascade, since the overall amplification is the product of the amplifications of the individual stages, whereas the total time-constant is, very roughly, the sum of the time-constants of the stages.

It is interesting to note that in the two papers the theoretical analysis proceeds along quite different lines, and different approximate-design techniques are developed. It is pointed out that a magnetic amplifier to control a given power output is ordinarily considerably larger than the corresponding power transformer, and supply frequencies in the range 400–1,600 c./s. are commonly employed in order to reduce the size of the equipment. The equivalent exponential delay of an amplifier is stated to correspond to a time-constant of the order of 2–100 cycles of the supply frequency.

JAMES GREIG

RECRUITMENT AND TRAINING FOR THE IRON AND STEEL INDUSTRY

IN order that the continuous and rapid technical developments in the iron and steel industry shall not outrun the capabilities of the men who will be required to operate the processes involved, the British Iron and Steel Federation has recently prepared recruitment and training schemes to benefit the industry as a whole. Based on the experience gained by various firms who have already developed training programmes of a far-reaching character, the Recruitment and Training Committee of the Federation has introduced a sample training scheme which has been circulated to all member firms. In order that the scheme should be fully discussed and improved, a Conference was held at Ashorne Hill, Leamington, on January 14–16, 1949, under the chairmanship of Mr. Gerald Steel, joint managing director of the United Steel Companies. The Conference was attended by representatives of member firms from all parts of Britain, and included production managers as well as personnel officers of various grades.

Pointing out that the number of youths in industry between the ages of 14–18 years had fallen from 3¼ millions in 1938 to 2½ millions in 1947, Mr. A. Goodram, of Samuel Fox and Co., Ltd., discussed the training of the junior operative both from the economic and social points of view. In his own Company the scheme began with a period of three weeks pre-entry training in which the change-over from school to work was cushioned and gave the boy and girl some idea of the shape and importance of the firm and of its general organisation. The boy's first job as a messenger lasted eight months, and during this time he obtained more information about individuals, departments and processes. The next phase of training was given in the workshops, when suitable boys were selected as craft apprentices. Junior operatives were then placed in production departments until they were called up for National Service; but during this time they would be given experience in at least three departments as well as opportunities for attending educational institutions on one day a week.

The director of training at Stewarts and Lloyds, Ltd., Mr. Graham Satow, then outlined a scheme for training craft apprentices and suggested re-introduction of the formal method of 'agreements'. Training should include both technical and general aspects, and should be the joint responsibility of the firm and the local education authority. For the more able apprentice, education up to the ordinary and higher national certificate standards should be provided, while for the craftsman who was good with his hands a less academic examination should be instituted. Practical training should be done by the firm, and should include experience in the use of hand and machine tools as well as the actual jobs associated with the boy's future work. Selected craft apprentices should be given both the opportunity of moving up to the technical apprentice-level and of sitting for State technological scholarships.

In opening a discussion on the training of technical apprentices, Mr. Cleghorn Thomson, chief education officer of Richard Thomas and Baldwins, Ltd., indicated that these would generally be recruited from grammar school boys of matriculation standard. His suggestions for training this type of apprentice presupposed that ultimately the heads and chief assistants in the chemical, metallurgical and fuel departments of the larger works would all be honours degree men, or associates of the appropriate professional bodies, that ordinary degree men would be in charge of the main sections under them, and that foremen testers and senior chemists and testers should have at least higher national and national certificates, respectively. Training of technical apprentices in the works should provide progressive movement linked up with their theoretical studies and success in examinations. The period of training would last about five years and would include time spent in other firms. During the ensuing discussion the doubt was expressed whether it would be practicable to insist on matriculation as the prerequisite for this type of entrant to industry, while the need for universities to provide more facilities for part-time studies was strongly advocated.

The training of clerical workers was introduced by Mr. D. R. O. Thomas, chief education officer to the United Steel Companies, who emphasized that this was an aspect of industrial training which had not been given the attention that its importance required and merited. The national certificate in commerce had not yet gained wide acceptance mainly because it had not been sponsored by any single authoritative body. This situation may be altered after the Carr-Saunders Committee, which is deliberating at present, has reported. The training should include preliminary instruction in the history and organisation of the firm, practical training in various departments and, concurrently with the practical training, theoretical training at a commercial college which should not be over-weighted on the vocational side. In summing up this particular session, the chairman insisted that the training provided "must wipe out that unfortunate figure, the routine clerk keeping up appearances on a miserable pittance".

Probably the most difficult subject at the Conference, training in the small firm, was tackled by Mr. A. Roebuck, technical director of Hadfield's, Ltd. Training in the small firm is as necessary as in the big firm, and Mr. Roebuck believed that this would be achieved if small firms would co-operate in groups on a trade or geographical basis. This is already happening in some parts of Great Britain, and in order to extend training facilities throughout the country it is proposed to set up local committees in various steel-making areas to help in the organisation of suitable training schemes. In this way large and small firms would be able to help each other, the small firm often making a contribution to training which was impossible in the bigger firm.

In surveying the work of the Conference, Mr. Geoffrey Summers, director of John Summers and Sons, Ltd., emphasized that all technical training needed to be reinforced with social and humanistic education in which young industrial workers should be taught how to make their leisure a period of profitable active enjoyment.

The Conference closed on an evangelical note with the following remarks by Mr. G. Steel. "We must proselytize. We must make everyone training-conscious. For the welfare of our own industry and the country as a whole, it is essential that we succeed. Only thus can we ensure that the best possible use is made of our strictly limited resources."

These words, and the calling of the Conference, indicate the way in which the iron and steel industry in Britain is adjusting itself to become more and more efficient in a world that daily grows more competitive.

T. H. HAWKINS

POTATO VIRUS X

THE drastic roguing which is performed on crops of potatoes for seed has resulted in a reduction of the amount of the more obvious viruses leaf-roll and rugose-mosaic. Potato virus *X*, however, causes a slight mottle of the foliage which is noticeable only under certain conditions of weather, and may often be missed by the roguers. F. C. Bawden, B. Kassanis and F. M. Roberts conclude, in a recent paper (*Ann. App. Biol.*, 25, No. 2, 250–265; June 1948), that the control of virus *X* must involve methods additional to those of field inspection. Presence of the virus in a stock of potatoes can be tested by inoculation to indicator plants and by serological methods. Spread of the virus is slow under natural conditions, and the authors conclude that the maintenance of stocks from which virus *X* has been eliminated by testing is feasible under commercial conditions. The virus reduces yield by 5–24 per cent; but it is refreshing to find the idea of clonal selection also considered along with questions of yield and loss due to virus.

Potato virus *X* is shown by F. M. Roberts (*Ann. App. Biol.*, 35, No. 2, 266–278; June 1948) to be transmitted by contact of leaves or roots. About ten per cent of healthy plants in contact with diseased.

ones become infected, and the more virulent strains of the virus spread more rapidly than the less virulent ones. The rate of spread is much greater in tomato than potato plants. *Datura stramonium* and tomato, indeed, become infected when grown in soil containing only sap or residues from virus-infected plants. The fungus *Rhizoctonia solani* cannot effect transfer of virus *X*.

Variations in the properties of virus *X* have been studied by F. C. Bawden and A. Kleczkowski (*J. Gen. Microbiol.*, 2, No. 2, 173; May 1948). Concentration of the virus extract by high-speed centrifugation or precipitation with acids and salts results in an insoluble form of the virus which is, nevertheless, infective and serologically active. Ribonuclease readily hydrolyses the nucleic acid derived from virus *X*, but has no action on the active virus.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, March 28—Wednesday, March 30

Chemical Society (joint meeting with the Chemistry Division of the Atomic Energy Research Establishment, at Rhodes House, South Parks Road, Oxford).—Symposium on "The Chemistry of the Heavy Elements".

Tuesday, March 29

Manchester Geographical Society (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Wm. A. Singleton: "Impressions of Sweden".

Institution of the Rubber Industry, London and District Section (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Prof. H. W. Melville, F.R.S.: "Redox Polymerization". (Members of the Plastics Group of the Society of Chemical Industry are invited.)

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Dr. C. Melville, Mr. H. Steinman, Mr. J. B. Lloyd and Mr. H. Burlinson: Papers on "Different Aspects of Pharmacy".

Wednesday, March 30

Physical Society, Colour Group (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 3 p.m.—Ninth Annual General Meeting; at 3.15 p.m.—Discussion on "Photoelectric Spectrophotometers and Tricolorimeters" (to be opened by Dr. T. Vickerstaff)

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Dr. Hill: "Chemistry at the Shirley Institute".*

Royal Institute of Chemistry, London and S.E. Counties Section (joint meeting with the British Association of Chemists and the Association of Scientific Workers, at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Discussion on "Part-time Education in Chemistry".

Wednesday, March 30—Friday, April 1

*Institute of Metals (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, on March 30 and 31, and at 4 Grosvenor Gardens, London, S.W.1, on April 1), at 10 a.m. each day—Annual General Meeting.

Thursday, March 31

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—108th Annual General Meeting; at 3.30 p.m.—Sir Ian Heilbron, F.R.S.: "Concerning Amino-acids, Peptides and Purines" (Presidential Address).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. H. Marsden: "Nylon Yarn Processing in U.S.A.".

Thursday, March 31—Monday, April 4

British Psychological Society (at Bristol).—Annual General Meeting.

Friday, April 1

Chemical Society (joint meeting with the Chemistry Division of the Atomic Energy Research Establishment, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 9.30 a.m.—Discussion on "The Use of Radioactive Tracers in Chemistry".

Society of Public Analysts and Other Analytical Chemists, Physical Methods Group (in the Chemistry Lecture Theatre, The University, Highfields, Nottingham), at 3.30 p.m.—Discussion on "Electrophoretic Analysis".

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. F. P. Bowden, F.R.S.: "Seizure of Rubbing Surfaces"; Dr. J. R. Bristow: "The Measurement of Kinetic Boundary Friction or the Experimental Investigation of 'Oiliness'".

Royal Statistical Society, London Group of the Industrial Applications Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W.C.2), at 6 p.m.—Mr. C. Wainwright: "Statistical Principles in Quality Specifications for Plastics".

Society of Chemical Industry, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. H. V. Potter: "Synthetic Fibres" (Jubilee Memorial Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. S. Tolansky: "The Examination of Crystal and Metal Surfaces using Interferometry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physical Chemists (Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London, for duties in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography, and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A (April 2).

Senior Scientific Officers and Scientific Officers (with a good honours degree, or equivalent, in physics, and an interest in photography from high-speed aircraft and in air survey photography) at the Royal Aircraft Establishment, Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.43/49A (April 2).

Responsible Lecturer in Mechanical Engineering, and a Lecturer in Mathematics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (April 2).

Physicists (Senior Scientific Officer and Scientific Officer grades) in Ministry of Supply Research and Development Establishments in South England and South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.42/49A (April 2).

Senior Experimental Officer in Ministry of Supply Headquarters, London, for the co-ordination of thermionic valve requirements and supervision of an information service on valves for Government Departments and associated organisations—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.69/49A (April 2).

Lecturer (qualified to teach up to B.Sc. general degree standard in Mathematics) in the Physics and Mathematics Department—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (April 2).

Senior Assistant in Physics at the Bradford Technical College—The Director of Education, Town Hall, Bradford (April 2).

Ventilation Engineer in the Production Department at the Board's Headquarters in London—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/126 (April 4).

Lecturer (Grade IIb) in Industrial Metallurgy—The Secretary, The University, Birmingham 3 (April 9).

Engineers or Physicists in the Hydraulics Research Organization (Department of Scientific and Industrial Research) for work in connexion with the design and development of new instruments for hydraulics laboratory and oceanographic research—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.51/49A (April 9).

Principal Scientific Officer (Ref. F.134/49A) to be responsible, under the Superintendent, for research on chemical, physical and engineering problems of flax cultivation and processing, a Senior Scientific Officer or Scientific Officer (Ref. A.36/49A) for research in connexion with fibre grading and testing, etc., a Scientific Officer (Ref. F.135/49A) to undertake research into some aspects of chemical and biological retting, etc., a Senior Experimental Officer or Experimental Officer (Ref. F.136/49A) to take charge of the chemical testing and analytical section, and an Experimental Officer or Assistant Experimental Officer (Ref. A.37/49A) to take charge of the technical library and information section, at the Norfolk Flax Establishment, King's Lynn—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 9).

Director of the Marine Biological Station which is being established at Bangor to develop the facilities for the study of Marine Biology within the University of Wales—The Secretary and Registrar, University College of North Wales, Bangor (April 9).

Lecturer in Agricultural Zoology—The Secretary of University Court, The University, Glasgow, W.2 (April 12).

Senior Biochemist to direct the research activities of a cell metabolism unit at the Australian Institute of Anatomy, Canberra—The Chief Medical Officer, Australia House, Strand, London, W.C.2 (April 14).

Lecturer in Pharmacology—Prof. J. H. Gaddum, Pharmacology Department, The University, Edinburgh (April 15).

Assistant in the Department of Natural Philosophy, University College, Dundee—The Secretary, The University, St. Andrews (April 15).

Lecturer (Grade III) in Geography—The Registrar, Queen Mary College, Mile End Road, London, E.1 (April 22).

Chemist to assist in research with radioactive isotopes—The Secretary and House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (April 22).

Lecturer in Animal Husbandry and Management, and a Lecturer in Pathology and Bacteriology, in the Veterinary School, Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (April 23).

Principal (woman)—The Secretary, Studley College, Warwickshire (April 29).

Post-Graduate Studentships (3) for research into stored products entomology in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

I.C.I. Research Fellowships in bacteriology, biochemistry, chemical engineering, chemistry, chemistry of leather manufacture, chemotherapy, colloid science, colour chemistry and dyeing, engineering (civil, electrical or mechanical), fuel and refractories, metallurgy, pharmacology physics, textile industries (protein chemistry)—The Registrar, The University, Leeds 2 (April 30).

Lecturers in Chemistry (special qualifications in physical chemistry required for one post and in technical chemistry for the other)—The Secretary, The University, Edinburgh (April 30).

Lecturers and Senior Lecturers in Physics—The Secretary of University Court, The University, Glasgow, W.2 (May 31).

Nuffield Research Studentships and Fellowships for experimental and theoretical research in nuclear physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 31).

Research Fellowship in Metallurgy—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 1).

Science Graduate, for bureau literary work—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

Senior Physicist to take charge of the researches on the physical aspects of rubber science and technology—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

Senior Technician (special knowledge of V.D. pathology essential)—The Pathologist, London Hospital Whitechapel Clinic, London, E.1.

Lecturer (up to B.Sc. standard) in Mathematics—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Physical Chemist or Physicist for research on the manufacture, properties and use of whiting, and an Information Officer to deal with library, abstracting and information services—The Director of Research, British Whiting Research Laboratories, 235 Ampthill Road, Bedford.

Lecturer in Botany—The Registrar, University College, Exeter.

Assistant Director of the Game and Tsetse Control Department, Government of Northern Rhodesia—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Chief or Senior Technician to take charge of the biochemical laboratory—The Chemical Pathologist, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

Lecturer, and two Assistant Lecturers and Demonstrators (one part-time) in the Department of Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

University Graduate (with first- or second-class honours in botany) for bracken investigations—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Laboratory Assistant in the Department of Biochemistry—The Secretary, University College, Gower Street, London, W.C.1, endorsed 'Biochemistry/2'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The W. H. Ross Foundation (Scotland) for the Study of Prevention of Blindness. Pp. viii+236. (London: University of London Press, Ltd., 1948.) 3*s*. net. [309

List of Recorded Cotton Insects of the World. By H. Hargreaves. Pp. 50. (London: Commonwealth Institute of Entomology, 1948.) 5*s*. [510

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 834, Vol. 241: Systematic Sampling. By Dr. F. Yates. Pp. 345–377. (London: Cambridge University Press, 1948.) 8*s*. 6*d*. [510

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 11: The Effect of the Soil Foundation on the Road Surface; an Outline of Existing Knowledge. By D. J. Maclean. Pp. iv+20+16 plates. (London: H.M. Stationery Office, 1948.) 1*s*. 3*d*. net. [710

Radio Valve Practice. Pp. 24. (London: British Radio Valve Manufacturers' Association, 1948.) [710

Fair Isle Bird Observatory. Pp. 15+16 plates. (Edinburgh: Scottish Ornithologists' Club, 1948.) [710

London County Council. Oxidation-Reduction Potentials in Bacteriology and Biochemistry. By Dr. L. F. Hewitt. Fifth edition. Pp. 130. (London: Staples Press, Ltd., 1948.) 4*s*. 6*d*. [1110

Medical Research Council. Memorandum No. 21: List of Species maintained in the National Collection of Cultures. Pp. iv+17. (London: H.M. Stationery Office, 1948.) 9*d*. net. [1110

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 835, Vol. 241: Large Elastic Deformations of Isotropic Materials, 4, Further Developments of the General Theory. By R. S. Rivlin. Pp. 379–397. (London: Cambridge University Press, 1948.) 4*s*. 6*d*. [1110

Ministry of Agriculture and Fisheries. The Mites Associated with Stored Food Products. By A. M. Hughes. Pp. iii+168. (London: H.M. Stationery Office, 1948.) 3*s*. net. [1310

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Standing Commission on Museums and Galleries. Third Report. Pp. 52+12 plates. (London: H.M. Stationery Office, 1948.) 1*s*. 6*d*. net. [1910

Department of Scientific and Industrial Research (Building Research Station). National Building Studies, Bulletin No. 3: Concreting and Bricklaying in Cold Weather. By A. J. Newman. Pp. iv+14. (London: H.M. Stationery Office, 1948.) 6*d*. net. [2610

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Commonwealth of Australia. Twenty-first Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June 1947. Pp. 139. (Canberra: Commonwealth Government Printer, 1948.) 6*s*. [209

Union of South Africa: Department of the Interior, Archæological Survey. Early Man in the Vaal River Basin. Part 1: The Earlier Stone Age or Old Palæolithic Industries in the Vaal River Basin, by Henri Breuil; Part 2: The Older Gravels of the Vaal, by C. van Riet Lowe; Part 3: Note on the Older Gravels of the Vaal between Barkly West and Windsorton, by Alex. L. du Toit. Pp. 35. (Pretoria: Government Printer, 1948.) 5*s*. [209

Proceedings of the California Zoological Club. (Published irregularly.) Vol. 1, No. 1, August 1, 1948. Pp. 8. (Stanford University, Calif.: California Zoological Club, 1948.) 5 dollars per vol. [229

Smithsonian Institution: Freer Gallery of Art. Occasional Papers, Vol. 1, No. 2: Paintings, Pastels, Drawings, Prints and Copper Plates by and attributed to American and European Artists, together with a List of Original Whistleriana, in the Freer Gallery of Art. By Burns A. Stubbs. (Publication 3905.) Pp. vi+152+20 plates. (Washington, D.C.: Smithsonian Institution, 1948.) [229

Tanganyika Territory: Department of Lands and Mines, Geological Division. Short Paper, No. 29: The Geology of the Country around Mwanza Gulf. By G. M. Stockley. Pp. 25. (Dodoma: Department of Lands and Mines; London: Crown Agents for the Colonies, 1947.) 3*s*. [239

Forest Administration Plan, Nigeria, 1946–55, under a Ten-Year Plan of Development for Nigeria, 1946. Pp. 42. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1948.) 9*d*. [299

Smithsonian Institution: Bureau of American Ethnology. Bulletin 143: Handbook of South American Indians. Edited by Julian H. Steward. Vol. 3: The Tropical Forest Tribes. Pp. xxvi+986+126 plates. (Washington, D.C.: Government Printing Office, 1948.) [510

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 25, No. 1: On the Morphology and Taxonomy of the Middle Devonian Osteolepid Fishes of Scotland. By Erik Jarvik. Pp. 301+37 plates. Serien 3, Band 25, No. 2: Spectra, Magnitudes and Colours of Stars in Regions of Different Galactic Latitude. 1: +20° Galactic Latitude. By Carl Schalén. Pp. 42. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1948.) [510

Report of the Caribbean Commission to the Governments of the French Republic, the Kingdom of the Netherlands, the United Kingdom, the United States of America, for the Year 1947. Pp. 32. (Port of Spain, Trinidad: Caribbean Commission, 1948.) 25 cents. [510

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Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 23, Memoir No. 2: Brachiopoda and Mollusca from the Productus Limestones of the Salt Range. By Dr. F. R. Cowper Reed. Pp. xii+596+65 plates. (Calcutta: Geological Survey of India, 1944.) 63.2 rupees; 96*s*. [510

A Bibliography of British Somaliland. By Major N. M. Viney. Pp. 36. (Burao: General Survey, 1947.) [710

Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous *Dana* Expeditions. *Dana* Report, No. 30: The Thecosomatous Pteropods, 2, The Indo-Pacific. By J. J. Tesch. Pp. 45+3 plates. 10 D.kr.: 10*s*. *Dana* Report, No. 31: *Chauliodus* Schn., Bathypelagic Genus of Fishes; a Systematic, Phylogenetic and Geographical Study. By Vilh. Ege. Pp. 148+2 plates. 32 D.kr.; 33*s*. (Copenhagen: C. A. Reitzels Forlag; London: Oxford University Press, 1948.) [710

Coryndon Memorial Museum. Occasional Papers, No. 2: Dimple-based Pottery from Central Kavirondo, Kenya Colony. By M. D. Leakey, the late W. E. Owen and L. S. B. Leakey. Pp. 43+8 plates. (Nairobi: Coryndon Memorial Museum; Cambridge: Deighton Bell and Co., Ltd., 1948.) 5*s*. [710

Annals of the New York Academy of Sciences. Vol. 49, Art. 5: Recent Studies in the Mechanisms of Embryonic Development. By E. J. Boell, D. P. Costello, S. R. Detwiler, G. Fankhauser, J. Holtfreter, J. S. Nicholas, S. M. Rose, D. Rudnick and L. S. Stone. Pp. 661–866. (New York: New York Academy of Sciences, 1948.) 3.50 dollars. [1110

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MSE 'Ato-Mix' Blender and Disintegrator. (Leaflet No. 130.) Pp. 2. MSE 'Chemical' Centrifuge. (Leaflet No. 122.) Pp. 2. (London: Measuring and Scientific Equipment, Ltd., 1948.)

Transmitting and Power Rectifying Valves. (Ref. SP.7/2.) Pp. 8. Receiving and Rectifying Valves (Ref. SP.8/2.) Pp. 12. Transmitting Valve Type D.E.T.17. (Ref. A.1/8.) Pp. 6. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1948.)

Voyages and Travel, Colonial and Dominion History, Slavery, Naval History, Ships and Shipping, Maps and Atlases, Jesuit Relations, Native Races and their Customs, etc. (Catalogue No. 691.) Pp. 130. (London: Francis Edwards, Ltd., 1948.)

Old Science, Part 1. (Catalogue 12.) Pp. 54. (London: E. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1948.)

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Standard Stock Sizes: Aluminium, Brass, Copper and other Non-Ferrous Metals. Pp. 48. (London: H. Rollet and Co., Ltd., 1948.)

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THE BRITISH SCIENTIFIC INSTRUMENT INDUSTRY

ON two occasions during the latter half of the war period, attention was directed in these columns to the important contribution which the scientific instrument industry would be called upon to make towards the rehabilitation of every phase of life in Great Britain, and to the achievement of normal national prosperity. The experience of the post-war years has shown that the demands made upon the manufacturers of scientific instruments have not merely been heavy; but, in consequence of the necessity imposed by economic circumstances for an accelerated achievement of industrial production and efficiency greatly in excess of pre-war standards, even more arduous than had been anticipated. The manufacturers of scientific instruments were, in common with members of many other industries, completely immersed in the war effort, and had not the opportunity—nor were they permitted—to indulge in any post-war planning. It is appropriate, therefore, at this distance from the termination of the War, to review the position and condition of this vital industry and to assess its ability to meet the very heavy responsibilities which still rest, and will continue to rest, upon it.

It is well to remember that the functions of a scientific instrument industry are far more complicated and diverse than was the case a generation or so ago. At that time, the predominant activity of the manufacturer of scientific instruments was concerned with the provision of instruments for educational, laboratory and research purposes. The main commitment of the instrument maker was to meet the demands of pure science; and, as a consequence, not only was there intimate contact with the world of science, but also something of the laboratory atmosphere permeated the scientific instrument works. To-day, while the fulfilling of the requirements of pure science remains a vital function of the instrument industry, yet the greatest demands for instruments come from the world of applied science, and in particular of industrial science. It should also be borne in mind that the scientific instrument industry is not a single industry, but is, in fact, a collection of several individual industries. The techniques of manufacture of the microscope maker have little in common with those of the maker of electrical instruments. The problems of the manufacturer of instruments of metrology differ markedly from both. This lack of common ground in manufacturing technique between different classes of instruments connotes an equal diversity in the scope of development work required to be undertaken by the industry, and it is not always realized that the total development effort of the industry has to be divided into numerous classes of development projects which are as diverse in their nature as are instruments themselves. The magnitude of the development field which has to be covered by the manufacturers of scientific instruments cannot be over-stressed, for much of the impatience which is more than occasionally shown towards the scientific instrument industry arises from the complete preoccupation of a particular section of users with a particular class of instrument, and a consequent—and, let it be said, understandable—over-estimation of the proportion of the total development capacity of the industry for dealing with particular development projects. Nevertheless, the ability to produce new instruments and to modify existing types of instruments to meet new and urgent requirements does provide the 'acid test' of the efficacy of the instrument industry and the main symptom of the state of its health. It is, however, appropriate that a timely reminder should be given of the onerous nature of the instrument maker's commitments in the development field, and to remark that only a very flourishing scientific instrument industry can hope to meet those commitments with adequacy.

Opportunities have occurred in the displays of instruments at successive British Industries Fairs, in the annual exhibitions sponsored by the Physical Society such as that held in London during April 5–8 at the Imperial College of Science and Technology, and in the trade shows at Stockholm and Copenhagen, of judging the progress made by the scientific instrument industry of Britain, which, it can be said, without much exaggeration, had almost to make a fresh start at the conclusion of the War. At the Copenhagen exhibition, the comments on British instruments were most favourable, and some sense of astonishment was expressed by Scandinavian users, whose practice it had been to obtain all their instruments from the Continent, at the range of instruments shown and at the excellence of their design. There can be little doubt that there is no longer any substantial measure of validity in the criticism so often levelled at the scientific instrument industry of Britain in the past, that it exhibited weakness in its design and engineering activities. A comparison of post-war and pre-war British instruments cannot but reveal that remarkable progress has been made, and clearly indicates the very considerable effort which has been made by scientific instrument makers. These developments have occurred at a time when instrument manufacturers have been called upon to make the greatest possible effort to increase the export trade in instruments. At the moment, British scientific instruments to the value of £10,000,000 a year are being exported, as compared with some £2,000,000 before the War. This diversion of instruments abroad has necessarily had an unfavourable impact on the dates of delivery of instruments to the user in Great Britain.

The effort which the industry has already made to revive its production of civil instruments after its long pre-occupation with military requirements, and to assist the general economy of the country by making its contribution to the export drive, has undoubtedly and inevitably placed some limitation on the magnitude of its development effort. In consequence, it has not been found possible for the instrument maker to meet in every case the eager demand of instrument users for new and particular types of instruments; yet the addition which a considerable export trade has made to the resources of the industry ought to mean that all users' requirements should be met in an increasingly adequate degree. There is little need to stress the vital character of the part which, in this technological age, instrument production plays in the life of an industrial nation, and the increasing dependence of the work of the men of science on the provision of specialized instruments. The ability of the scientific instrument industry to play this part is, however, dependent upon its total volume of trade, and the recent expansion of its export trade was welcomed as offering potential resources which would enable the provision of scientific instruments in Great Britain to be achieved in a more worthy and complete manner than ever before. The revival of the German scientific instrument industry, in economic circumstances which are particularly favourable to that revival, does therefore create a problem, the solution of which demands serious attention. The official prognosis is that the trade in British instruments must inevitably shrink; this, in the long run, can only mean that the ability of the instrument manufacturer to meet, through his research and development activities, the continuous and varied requirements of instrument users in Great Britain, must correspondingly decrease. Such a situation cannot be faced with equanimity, since its repercussions are so vital and so widespread. The soundness of the reasons which have compelled the Allied control authorities in Germany actively to assist industrial revival is patent. The implications of that revival in respect of the ability of the British scientific instrument maker adequately and abundantly to produce scientific instruments, which provide the means of scientific research and the key tools of industrial efficiency—and ultimately profoundly affect the amenities and standard of life—should, however, not be forgotten. The problem is more complex than appears at first sight, and should be given very serious and practical thought.

CARBOHYDRATE CHEMISTRY

Chemistry of the Carbohydrates

By William Ward Pigman and Rudolph Maximilian Goepp, Jr. Pp. xvii+748. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 10.80 dollars.

The Chemistry of the Polysaccharides

By Dr. Robert J. McIlroy. Pp. vii+118. (London: Edward Arnold and Co., 1948.) 10*s*. 6*d*. net.

An Introduction to the Chemistry of Carbohydrates

By John Honeyman. Pp. vii+144. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 15*s*. net.

FEW fields of investigation in organic chemistry have shown more rapid or more spectacular advances than has been the case with the carbohydrate group. Once methods had been developed for precise structural determinations of the monosaccharides and disaccharides and their derivatives, a vast range of natural products became open for detailed study. The position then reached (1929) was depicted in Sir Norman Haworth's classical memoir "The Constitution of Sugars". Since that time the carbohydrate group has been the subject of continuous and intensive investigation by physical, chemical and biochemical methods, with the result that considerable further insight has now been gained into the molecular structure of the polysaccharides, including celluloses, starches, glycogens, pectic materials, plant gums and mucilages, and bacterial polysaccharides.

These developments in the chemistry of complex substances of high molecular weight are by no means the whole story. The simple sugars also have shown an amazing versatility of reaction and, selecting only one or two examples, we may recall the progress made in the study of the anhydro-sugars, the sugar alcohols, ascorbic acid and its analogues, and the amino-sugars. Much has been learned also of the behaviour of sugars towards enzymes, notably in regard to the mechanism of alcoholic fermentation and muscular contraction, and concerning the enzymic synthesis and break-down of amylose, amylopectin and glycogen. There is, therefore, an urgent need for new text-books which will incorporate these recent advances, and the books now under review may be taken as representative of three different approaches to the problem of recording knowledge in this field.

"Chemistry of the Carbohydrates", by W. W. Pigman and R. M. Goepp, is a large-scale monograph which provides a comprehensive survey of the broad field with full literature references up to 1946–47. It contains a wealth of information, including details of historical developments, and will be indispensable to all postgraduate students and research workers on the carbohydrate group. The material is clearly and accurately presented with adequate diagrams, and very little that is of importance in carbohydrate chemistry has escaped the authors' notice. The book, however, does not claim to be as comprehensive and detailed as the "Tollens–Elsner Handbuch" of 1935, and, from the point of view of the research worker, it is not so conveniently arranged. The difficulty seems to be that the authors have attempted to combine in one volume the features of a reference book with those of a large-scale text-book, with the result that, despite the careful and elaborate system of indexing, it is often difficult to track down a particular item of information. One could cite, for example, the way in which references to partially methylated sugars are scattered through the volume, while in the chapter which is designated "Ethers, Anhydrides and Unsaturated Derivatives" little collected information on the methyl ethers is provided. As a test case, let the reader attempt to ascertain from the book how to prepare 4-methyl glucose. The volume does, in fact, contain a literature reference pointing to this topic, but it appears unexpectedly in a section on optical rotatory power (p. 515) and does not appear in the index. The book is, however, the only one of its kind in the English language, and in view of its clarity and comprehensiveness (the index alone occupies 100 pages) it will be given an enthusiastic welcome by all who are seriously concerned with sugar chemistry.

R. J. McIlroy's "The Chemistry of the Polysaccharides", deals mainly with modern work on polysaccharides, a field in which new knowledge has been accumulating so rapidly that the author has been compelled to add an appendix giving advances which took place while the main body of the book was being printed. The accounts are clear and precise, with useful and adequate literature references. Their brevity is such, however, that they are likely to be of greater value to postgraduate students than to readers seeking some general knowledge of main achievements in polysaccharide chemistry. There is a most useful chapter on the methods of estimation of sugars, but it would have been more profitable to utilize the space devoted to "Derivatives of the Monosaccharides" for a more detailed description of the polysaccharides.

The third book on the list, J. Honeyman's "Chemistry of Carbohydrates", can be unreservedly recommended as an excellent introduction, on modern lines, to the structural chemistry of the sugars. It presents clearly the fundamental background of the subject, with the arguments set out in a way which renders the book specially valuable for undergraduate instruction and for readers who wish to obtain a general picture of this field. The scope is strictly confined to the structural chemistry of the sugars; but within this range the book contains a balanced account of the methods used in the investigation of both the simple and complex carbohydrates, with well-chosen examples to illustrate the results achieved.

E. L. HIRST

HINDU LIFE THROUGH THE AGES

Hindu Kinship

An Important Chapter in Hindu Social History. By Dr. K. M. Kapadia. Pp. xvi+320+xxxv. (Bombay: Popular Book Depot, 1947.) 15 rupees.

INDIAN sociology has for long been a subject of lively activity among anthropologists working in the field. Their activities have been devoted to the study of existing institutions, in all their variety, on the Indian sub-continent. Historical studies based on the study of literary documents, and so forth, have been pursued to a much less extent in this field. Yet it is important that such investigations should not be neglected, since these social organisms can only be fully understood in the light of their historical evolution and by the analysis of their diverse origin. Dr. K. M. Kapadia's book is therefore to be welcomed. It consists of a detailed and careful analysis of the data to be found in Sanskrit literature dealing with the family and its organisation. The author has decided to call his book "Hindu Kinship" rather than "Brahmin Kinship" because of the Brahmin habit of setting "the stamp of orthodoxy wholesale on many religious beliefs and social relationships that were alien to their own culture". Nevertheless, the subject-matter of the book corresponds more to a title "Brahmin Kinship". This is mainly what is dealt with in the law books and other literature which are analysed here. Practices outside the orthodox field are referred to casually, rather than systematically, and as exceptions to the norm rather than as constituents of different systems.

Beginning with the cult of the Manes, which is prominent from the earliest period, the author proceeds to the subjects of marriage, family organisation, adoption and affiliation, inheritance and succession, vicarious liabilities, and debts, and birth and death impurities. All these are subjects which are exhaustively treated in Sanskrit law books and allied tracts. Dr. Kapadia's book is in a way more philological than sociological, in the sense that its main pre-occupation is to find out what the texts really say. This is as it should be, since without a solid philological basis the material cannot be safely used for further work. It is also historical, so far as the chronology of the texts allows, and such changes as have occurred in the course of three thousand years are followed in detail. What is noteworthy is the small amount of change, at any rate in the orthodox interpretation, that has taken place in this period. The patriarchal pattern of family life which was introduced by the Aryan invaders remained in its essential principles unchanged throughout the history of Hinduism. The main course of development is an increasing strictness in the upholding of the various restrictions applied in this field, and to some extent an increase in their number.

Dr. Kapadia has provided for students of sociology a comprehensive and reliable account of this subject as it is found in the Hindu law books. Most of the essential material that is available is collected and presented here in a clear and systematic manner.

MATERIA COSMETICA

The Principles and Practice of Modern Cosmetics

By Ralph G. Harry. Vol. 2: Cosmetic Materials; their Origin, Characteristics, Uses and Dermatological Action. Pp. xi+479. (London: Leonard Hill, Ltd., 1948.) 35s.

MR. R. G. HARRY'S book passes under a sober English title, and perhaps the flamboyant Latinesque alternative could scarcely exist; yet it would have seemed almost permissible to invent it for a work as well-informed in scientific facts and as carefully responsible in its verdicts, as one could require in the treatment of the materia medica. The comparison is the more readily prompted by the pharmacopœial design of the book, in an alphabetical series of monographs, each subheaded with the synonyms, composition, provenance, properties, toilet uses and dermatological effects of its subject.

The author, indeed, refers specifically to the "diminishing gap between toilet manufacture and the preparation of remedial and healing skin creams", and deals judiciously with such medicinal constituents as penicillin, vitamins and hormones. A comprehensive and very readable monograph on "Herbals" reviews the claims of herbal ingredients, from early tradition down to recent findings on the bacteriostatic effects of chlorophyll and of plant juices from many different genera. Other topics in which the author carries the concept of 'cosmeticology' well beyond that of pure adornment are antiseptics, insecticides, insect repellents, sun-screening compounds and depilatories. Here, as elsewhere in the book, medical and dermatological findings are amply illustrated by references to original papers.

Space is also found for the treatment of such adjuncts to preparative manipulation as activated carbon for refinement of oils, fat-antioxidants and preservatives for finished products, and 'distilled water' prepared by adsorption. The greater part of the book, however, is naturally concerned with the basic materials of those creams and emulsions of which so many cosmetics largely or wholly consist. These include the following: most types of dispersing agents, for example, sulphated and sulphonated fatty bodies, quaternary ammonium salts, and soaps both organic and inorganic; dispersible fats and waxes such as those of the 'Lanette' type, wool-wax steroids and the 'mono-ester' class derived from fatty acids and polyhydric alcohols; the cellulose ethers and ether-esters, and alginates. It is hard to recall any previous treatment of the fatty group which supplies so much valuable matter in so concise a form. Thus, the thirteen pages devoted to fatty esters of polyhydric alcohols discuss in detail the manufacture and uses of the class, and give the usual 'fat constants' for twenty-seven American and twenty-eight British types—mono- and di-stearates (oleates, laurates, etc.) of glycerol, of ethylene and propylene glycols, and of mannitol and sorbitol.

It will be clear that the value of these sections is not only for the specialist in cosmetics. Most of the substances described have many other applications; one may cite the use of dispersible fats and emulsions in foodstuffs. The problem they present to the general analyst has so far been comparable to that which would be presented by the natural oils and fats if no accumulated data of iodine values and other 'fat constants' were available. That the two problems can be reduced to exactly the same footing is unlikely, if only because the caprices of manufacturers outnumber those of Nature herself; but Mr. Harry's contribution is a highly serviceable one, especially in that he has clearly enjoyed the confidence and co-operation of many leading manufacturers both in Great Britain and the United States.

One remains, indeed, a little uncertain as to how far the book has reference to British practice and how far to American. Pharmacopœial standards, which are given where relevant, refer to the "British Pharmacopœia". The standard specifications given for eleven generally used materials such as beeswax, borax and glycerin are those of the United States Toilet Goods Association. "British Industrial Methylated Spirit" is accorded a monograph, but except for a mention of denaturant use under "Diethyl Phthalate" there is no guidance on denaturing to British Excise requirements; yet sucrose octa-acetate has a monograph solely in virtue of its use as a denaturant, which is surely very infrequent in Great Britain. The use of the insect-repellent 'Indalone', which must be practically confined to the United States, is recorded, as is the similar application of dimethyl phthalate; but the discussion of diethyl phthalate omits its common British use in conjunction with the dimethyl compound; and dibutyl phthalate is not noticed. The colouring matters described are those 'certified' by the United States Food and Drugs Administration; this section has, however, a well-considered preface on the significance of the United States regulations and the desirability of similar British control.

This survey, though by no means fully exhibiting the scope of the book, will indicate the great variety of its matter and the amount of cross-reference involved in its most profitable use. For such use the simple alphabetical arrangement seems scarcely adequate, especially as there appears to be no consistent rule of titling the monographs either by commercial or by scientific names. Thus, 'Cellofas' (sodium carboxymethyl cellulose) figures under its trade name, while 'Collocel' (sodium cellulose glycollate) is under its chemical name. Other similar examples could be quoted. Though the book must already represent a most formidable labour of compilation, a detailed index would seem a merely just expenditure of tar for so gallant a ship.

E. G. KELLETT

The Theory of Solutions of High Polymers

By A. R. Miller. Pp. vii+118. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 12*s.* 6*d.* net.

THIS is a specialized monograph on a topic of great current interest. The thermodynamical behaviour of high-polymer solutions is of importance for many reasons. First, molecular size and shape can be determined if sufficient is known of the physical properties of the solution. Second, the intrinsic interest in the problem is a challenge to the theorist to get to grips with an exceptionally difficult problem. Even the proper understanding of the kinetic behaviour of high-polymer solutions is dependent on accurate knowledge of the system.

High-polymer solutions at all concentrations deviate so much from ideal behaviour that no slight extension of the theory of solutions is sufficient even to cover the case of very dilute solutions. Before the problem can be tackled statistically an acceptable model must be chosen. Dr. A. R. Miller therefore makes his choice and proceeds to develop the consequences, using all the laws of statistical thermodynamics. The first step is to calculate the free energy of mixing on the basis that the solution is athermal. Although there is not, unfortunately, a wealth of experimental data, the agreement between theory and experiment is surprisingly good, and demonstrates conclusively that the theoretical attack is along the right lines. When this simplification does not hold, matters are a good deal more complicated, and there are still discrepancies to be cleared up; but again the matter is put on a solid theoretical footing. More experimental work is needed to provide the basis for the construction of more accurate models suitable for statistical treatment.

H. W. MELVILLE

Flora of South Australia

(Handbook of the Flora and Fauna of South Australia, issued by the South Australian Branch of the British Science Guild, now incorporated with the British Association for the Advancement of Science.) Part 2: Casuarinaceæ–Euphorbiaceæ. By J. M. Black. Second edition. Pp. 253–521. (Adelaide: Government Printer, 1948.) 8*s.* 6*d.*

A SECOND edition of J. M. Black's well-known "Flora of South Australia" is in course of publication. The part recently received deals with the families of Dicotyledons from Casuarinaceæ to Euphorbiaceæ inclusive, essentially in the sequence of Engler and Gilg's "Syllabus der Pflanzenfamilien". Keys, descriptions and illustrations combine to make this a very practical flora. It is issued by the South Australian Branch of the British Science Guild (now incorporated with the British Association for the Advancement of Science.)

Families of particular interest include Casuarinaceæ, Proteaceæ, Chenopodiaceæ, Amarantaceæ, Aizoaceæ, Cruciferæ, Leguminosæ, Rutaceæ and Euphorbiaceæ. The species of Proteaceæ are less numerous than in some other States of the Commonwealth, and are represented by eight genera, of which *Hakea* with fifteen species and *Grevillea* with the same number are the largest genera. The Chenopodiaceæ, besides containing a considerable number of introduced weeds, are well represented in coastal and dry country habitats. *Bassia*, with 31 species, *Kochia* with 24, and *Atriplex* with 31 (of which three are introduced) are the largest genera. Many of the species of Cruciferæ are introductions, but there are a number of genera endemic to Australia, such as *Blennodia*, *Menkea* and *Phlegmatospermum*, while a few widely ranging genera, as *Lepidium*, have species limited to Australia. The largest family included in this part of the flora, the Leguminosæ, has many endemic genera and endemic species of more widely distributed genera. *Acacia*, with 89 species, is important taxonomically and ecologically in South Australia, and probably gave considerable trouble to key. *Pultenæa*, with 24 species, and *Swainsonia*, with 30, are other large genera. A large number of clovers and medicks have been introduced.

W. B. TURRILL

An Introduction to Organic Chemistry

By Prof. Ira D. Garard. Third edition. Pp. xi+396. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 21*s.* net.

THE author's aim is to give a concise rounded-off course of organic chemistry for students such as those of agriculture, home economics and medicine to whose main studies chemistry is ancillary. The contents comprise the simpler aliphatic and aromatic compounds usually described in an introductory course, together with a suitable scheme of practical work. Each chapter ends with a list of problems for study and a list of references.

By omitting matter requiring effort, such as the application of modern theories of valency to structure and reactions, and by stressing the economic uses of organic compounds, the author has made a most readable book. Thus we find him discoursing on proteins, rubber, nylon and dyes not only attractively but also in the light of modern knowledge. Prof. Garard handles his descriptive matter skilfully; his account of the paraffins includes the cyclic isomers, and his particularly well-written chapter on fats contains seven tables of information. His exposition of unusual terms such as 'azeotropy' and of new materials such as 'aerosols' is alike simple and adequate. For the above class of students this is a stimulating and interesting book.

G. F.

The Pharmaceutical Pocket-Book

Fifteenth edition. Pp. x+430. (London: Pharmaceutical Press, 1948.) 12*s.* 6*d.*

"THE Pharmaceutical Pocket Book" has come to serve two purposes. It introduces students of pharmacy to the principles on which their profession is based, and it serves as a book of reference for the practising pharmacist. The new edition includes the many changes introduced by the new "British Pharmacopœia" which was published in 1948, and a summary of those provisions of the National Health Service Act which affect pharmacists. There are 20 pages devoted to biochemical analysis and 10 pages of notes on bacteriology. There is a dictionary of synonyms and trade names which occupies 77 pages. This is a formidable, but in some ways a disappointing, list. It is devoted mostly to archaic and picturesque synonyms which cannot be much used nowadays. It contains devil's dung, dragon's blood, doom bark, essence of smoke, hippo wine, little liver pills, madweed, mandrake and nihil album, but not benadryl or neoantergan, 'DOCA', 'BAL', mapharside, 'DFP', dolantin, demerol, priscol, paludrine or promin. The list would be more valuable if it was brought up to date. There should surely be, either here or somewhere else in the book, a guide to modern synthetic drugs. However, the book contains much information and will, no doubt, serve a useful purpose.

CHEMOTHERAPY OF *T. CONGOLENSE* INFECTIONS WITH PHENANTHRIDINE COMPOUNDS: BIOLOGICAL ASPECTS

By PROF. C. H. BROWNING, F.R.S.
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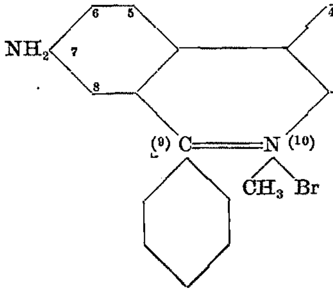
IN the editorial article, "Sleeping Sickness and Nagana" (*Nature*, January 15), mention is made of phenanthridine compounds in the treatment of cattle infected with *T. congolense*. The following details are likely to be of interest for their theoretical bearing and also because more than two million doses of one of these drugs, 2 : 7-diamino-9-phenyl-10-methylphenanthridinium bromide (No. 1553 or 'dimidium bromide', see formula), have been administered to cattle in Africa, and very considerable outbreaks of trypanosomiasis have been controlled by its use (*The Times*, February 9).



Formula of No. 1553

Phenanthridine compounds synthesized by the late Sir Gilbert Morgan and Dr. L. P. Walls at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington, were examined by us for anti-infective properties (antiseptic[1], etc.), the work being supported by the Medical Research Council. *Inter alia*, it was found that 7-amino-9-*p*-aminophenyl-10-methylphenanthridinium chloride (No. 897) had definite chemotherapeutic action on experimental infection in mice both with *T. brucei* and *T. congolense*, although the effective dose approached the toxic limit[2].

In view of the refractoriness of *T. congolense* to most chemotherapeutic agents which act powerfully on *T. brucei*, and the serious economic effects of African cattle disease caused by the former, the work was continued. We then observed that a much smaller dose of compound No. 897 than originally stated was capable of sterilizing *T. congolense* infection[3]. On exploring this discrepancy, the knowledge gained enabled therapeutic experiments to be conducted under fairly uniform conditions. Also, for the first time apparently, a drug with powerful curative action on *T. congolense* was available. Accordingly, a study has been made of the responses of this parasite to chemotherapeutic agents, several strains being used[4,5].

It was discovered that *T. congolense* undergoes biological changes according to the duration of the infection, which markedly affect its therapeutic sensitiveness. In order to obtain consistent results, it is essential always to transfer the trypanosomes to a fresh mouse as soon as they become abundant in the blood, that is, at 'acme'. A strain so maintained is termed an 'acme strain'. After acme the parasites either may persist in the blood in large numbers for several days to many weeks, until the animal finally succumbs to the infection, or a relapsing course may be established, the number of trypanosomes in the blood fluctuating greatly from time to time and death occurring during an access. In general respects, the condition in mice resembles passably the natural disease in cattle. An occasional striking feature in heavy protracted infections in mice is stasis in the tail and ears, which become dark purple-red and undergo necrosis unless treatment is given.

When the infection becomes chronic (that is, when the animal lives for more than several days after acme), a larger dose of the drug is required for sterilization than suffices at acme. Further, this diminished therapeutic response is shown also in fresh animals inoculated with such a 'chronic variant' strain. It is noteworthy with the acme strain that when treatment is administered at an early stage of infection, before parasites have become abundant in the blood, a larger dose of the drug is required to effect cure than at acme. This contrasts with *T. brucei* infections in mice and suggests that the immunity reaction following destruction *in vivo* of *T. congolense* plays a very significant part in bringing about sterilization—at least through the agency of phenanthridine drugs. The trypanosomes derived from a chronic infection have also the characters of a 'relapse strain', that is to say, an animal sterilized of an infection with the acme strain, while immune to re-inoculation with the same strain, becomes infected on re-inoculation from a chronically infected mouse. This relapse character may persist for a considerable time when such a chronic variant strain is subjected to a series of passages. Eventually, however, the original acme character seems to become re-established. (Our various acme strains were obtained by prolonged acme-passage through mice until the infection became accommodated.) The relapse strains of *T. congolense* showed a remarkable difference from those of *T. brucei* originally described by Ehrlich. A mouse cured of infection with a relapse strain of the latter is susceptible to the original strain; but this is not the case with *T. congolense*. However, later work has shown that this feature is not exhibited by all acme strains of the parasite; for example, animals cured of infection with a chronic variant of the 'Busimbi' strain are not immune to re-inoculation with the corresponding acme strain[6].

Of the series of phenanthridine compounds prepared by Dr. Walls[7] the most effective against *T. congolense* is No. 1553 (*vide supra*)[5,8]—with mice the ratio of the maximum tolerated dose to the minimum curative dose (more than 50 per cent cured), injected subcutaneously at acme, being 400 : 1 to 40 : 1 according to the strain. With No. 897 the ratio is 100 : 1 to 10 : 1; the less favourable results of Fulton and Yorke[9] may be explained by the early stage at which treatment was carried out[8]. We have not yet compared 'Antrycide' under similar conditions; but no other substance so far known approaches No. 1553 in efficacy (see also Wien[10]). In infected cattle the superiority of No. 1553 over No. 897 was also manifest. Of course, in cattle the 'therapeutic index' is much lower[8]; but a single dose of No. 1553 at the rate of 1·5–2·0 mgm. per kilo of body-weight injected into the tissues or intravenously is usually well borne and appears to be the standard curative dose (Carmichael and Bell[11]). Neither No. 897 nor No. 1553 protects normal mice for longer than a few days (less than four or five) when a large dose is injected subcutaneously and the animals are afterwards inoculated. Prophylactic action in cattle for two to four weeks has been reported, however (Crawshaw[12], Stewart[13]).

The occasional occurrence in cattle, some weeks after treatment, of toxic symptoms resembling photosensitization (Bell[14]) has been an undesirable complication of therapy with phenanthridine No. 1553. The precise conditions determining the development of those effects have not been defined. Similar phenomena have been recorded apart from treatment, and nothing comparable has been produced in small rodents (Brownlee *et al.*[15]). Where cure fails to occur in cattle, the relapses seem generally to be less amenable to further dosage with phenanthridine drugs. This soon emerged with No. 897, and has been attributed to the rapid acquisition of drug-resistance by the trypanosomes. But our persistent attempts to produce drug-fast strains in mice by the various known methods have failed; for example, where repeated relapses were on each occasion treated with a single injection of a dose curative for less than 40 per cent of original infections at acme, sterilization was effected ultimately in the same proportion, cure resulting even after the twentieth relapse[4,5]. The diminished therapeutic response in relapsed cattle seems similar to our observations with chronic strains in mice. By analogy, it is possible that drug-fastness of the trypanosomes may develop more readily in one species of host than in another. But the problem as regards cattle requires more extensive investigation than it seems to have received so far.

On comparing acme strains derived originally from different natural sources, marked differences were found in virulence, susceptibility to the chemotherapeutic drug and 'solidity' of immunity to re-inoculation with the homologous strain following cure[4,5,8]. As regards immunity, with one strain animals were refractory to a single massive re-inoculation more than a year after cure, or to repeated re-inoculations over this period. This suggests a method of protecting herds by artificial inoculation followed by treatment. On the other hand, with another strain only 50 per cent of animals resisted re-inoculation even after recent cure; and of these again, 50 per cent became infected after a second re-inoculation and so on. Little or no cross-immunity exists between different acme strains. Those differences have persisted without noteworthy change during many years of 'syringe-passage'. It remains to be determined whether in their natural habitat strains from cattle in one locality show considerable uniformity, or whether a variety of strains with distinct characters exist side by side in the same place.

T. vivax infection (in cattle) also responds to the phenanthridine compounds which are effective against *T. congolense*; but no member of the series is very potent toward *T. brucei*. *T. cruzi* infection in mice (one strain tested) is influenced by certain members[16], especially 3-carbethoxyamino-9-*p*-carbethoxyaminophenyl-10-methylphenanthridinium chloride (or methanesulphonate) and also 2 : 7-dicarbethoxyamino-9 : 10-dimethylphenanthridinium methosulphate, neither of which acts on *T. congolense* or *T. brucei* except in maximal doses.

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METEOROLOGY IN AGRICULTURE

THE ordinary meeting of the Royal Meteorological Society on March 16 took the form of a discussion of weather problems in farming, three speakers presenting prepared papers. As these papers could not be circulated in advance, they had to be read in full, so that general discussion was restricted in time, and would have been even more so if one of the three had not been self-sacrificing by confining himself to a few comments.

Opening the meeting, Dr. H. L. Penman directed attention to three kinds of problem: statistical, biological and physical. Statistical problems include, among others, the forecasting of both weather and crop yields. Of the former, he said that when they could be obtained, long-range forecasts would be of immense value; but even the scope of present-day forecasting technique could be made more useful to farmers, and this point was emphasized in the later discussion by Dr. J. Meiklejohn, who urged the establishment of a regional forecast service designed in language and scope for the particular needs of farmers and not exclusively for the benefit of agricultural scientists. Dr. Penman stated that attempts to forecast crop yields from weather data had a long history of failure, a failure due to neglect of the biological side of the problem; but in spite of his plea that future activity of this kind should start with biological measurements, Prof. Dudley Stamp asked that more meteorological measurements should be taken to help land utilization experts and town planners to do their job less harmfully to farming interests. Another contributor to the discussion, Mr. A. W. Ireland, from the Sudan, pointed out that yields of irrigated cotton can be predicted with considerable certainty merely from a knowledge of rainfall before sowing.

Biological problems, Dr. Penman continued, involve quantitative study of the growth, spread and decay of biological activity and their dependence on weather, and present a wide field for research in general and local meteorology and in micro-meteorology, in which the objective must be to answer some particular biological question. Some of these problems present a challenge to meteorological physicists on their own ground, for turbulent transport of spores and pollen involves the same ideas as turbulent transport of heat and water vapour, but are at least one degree more difficult because the suspended material has a terminal velocity of settling too big to be neglected in the analysis. Physical problems of importance in farming include not only the analysis of this turbulent diffusion, but also study of the heat balance of the earth—always of importance, but particularly so in investigating early summer radiation frosts—and of the water balance, since water is indispensable in any system of farming.

As an illustration of the application of fundamental physical research to practical farming, Dr. Penman then outlined work recently done at Rothamsted on the relation between weather and water consumption by crops. Because of the large latent heat of vaporization of water, much of the incoming energy from the sun is used up in evaporating water—if the water is there to be evaporated—and by measuring or estimating other components of lesser importance it is possible to draw up an energy balance-sheet in which the only unknown is evaporation. This theoretical work can be employed in practice to estimate the transpiration-rate from a fresh green crop with an adequate water supply, given measurements of wind speed, air temperature, dew-point temperature and duration of bright sunshine. The condition of 'adequate water supply' being the condition aimed at in any good irrigation system, the treatment is directly applicable to irrigation control. To demonstrate this, he described an experiment on irrigation of sugar beet on a Surrey market garden during 1948 in which one of the irrigation treatments was controlled on the basis of data returned weekly from a small weather station set up on the experimental field. In the course of the summer, irrigation was called for three times (total applied, 2·6 in.), but in all cases subsequent rainy periods rendered these irrigations superfluous, or almost so. In addition to unirrigated control plots, a third set was irrigated at the farmer's discretion (five times; total applied 4·7 in.), but because natural rainfall was estimated to have been entirely adequate, no major differences in yield were expected. Nor were they obtained, though there was a slight, non-significant bias in favour of the plots that had restricted irrigation. Soil samplings before and during the cropping confirmed the weather-based estimates of the amount of moisture removed by the crop.

Dr. L. Broadbent then gave a survey of the weather problems encountered by biologists, with particular reference to the potato. His main concern was the intervention of weather in attempts to produce full yields of healthy potatoes; but he commented also on problems of storage in clamps and the degree of thermal and physical insulation that must be provided to prevent too rapid heat loss in cold, moderately calm weather and to prevent penetration of cold air in windy weather. Logically, it can be interpolated here that Mr. R. W. Gloyne also made a brief reference to deterioration of 'seed' potatoes during transit from Scotland to southern England, and the problem of determining night radiation losses of heat from the railway trucks in which the potatoes are carried.

The need for this annual transfer of seed took up the greater part of the remainder of Dr. Broadbent's paper. Because of the weather conditions in the seed-raising areas and the general absence of winter host plants for the insect vector, the seed from Scotland arrives almost, if not completely, free from virus disease. Odd tubers, however, might have such a disease, and potatoes left in the ground from an earlier crop might have it, so that invariably all English potato crops carry a few nuclei of infection. The infection is spread by the aphid, *Myzus persicæ*, and Dr. Broadbent gave an interesting account of his experiments to determine those micro-meteorological conditions within the potato crop that would lead to insect movement from plant to plant, or inhibit it; since the insect carries the disease with it, the study of spread of the disease is, in fact, largely the study of the movement of the insect. He first showed the inadequacy of Stevenson screen temperatures as guides to what is happening inside the crop, and although in the later discussion there were some good-natured sallies against such screen readings, the chairman, Mr. E. Gold, clearly expressed the feeling of the meeting in stating that while for general synoptic surveys the standard screen is adequate, for particular problems data would have to be collected in other ways. To this Mr. W. H. Hogg added the comment that night minima in the screen seem to be reasonably representative of those measured in Dutch lights at ground-level.

Dr. Broadbent also gave an account of work, largely exploratory and still in the pioneering stage, aimed at measuring temperature and humidity gradients, and the degree of air movement, inside potato crops of different spacings and vigour. The aphid will not fly if the air-speed around it is more than 3–4 m.p.h.; but even the early results show conclusively that flying conditions may often be suitable inside the crop when they are unsuitable outside, so that a chance eddy, or an imprudent excursion, may take the insect out into the faster-moving air to be swept uncontrollably along to another part of the same field, to another field, or even to another county—carrying infection with it if it was previously feeding on an infected plant.

It was unfortunate that Mr. R. W. Gloyne, of the newly formed Agricultural Branch of the Meteorological Office, had to compress his remarks, but even so he gave a fascinating glimpse of his activities as meteorological attaché to the south-west province of the National Agricultural Advisory Service in Britain. He, too, was concerned with potatoes, not only with the transit of seed and storage of tubers but also with the possibility of issuing special weather forecasts of the imminence of the hot humid conditions that lead to rapid multiplication of the spores of potato blight, one of the few diseases that has a clearly marked and fairly well-known association with a particular type of weather. Of special forecasts in general, he, like a later contributor to the discussion, pointed out that farming has to go on whatever the forecast, and that we must be careful not to over-estimate the value of farmers' weather forecasts, particularly for men working on a small scale. For large units, however, such forecasts might realize their expected value.

The scale of farming activity and its dependence on weather appeared also in another of his topics, which he referred to as "farming climatology". Many harvesting operations, of which haymaking is an outstanding example, can only be successfully carried out if there is a certain weather sequence, usually of days without rain, at the time of the operation; the amount of crop that can be successfully harvested is limited by the length of this suitable period, by the labour and equipment available for the job, and by the technique used for the operation. For a given size of farm with normal staff and equipment, the optimum area of crop will be limited by the probability of getting the necessary weather sequence and by the harvesting technique. For hay, eastern England can count on a long sequence of good haymaking days, so the technique used there may not be equally successful in the south-west with its higher and more frequent rainfall; the most effective technique for the south-west would be one making some allowance for the climate of the region.

A further general topic led Mr. Gloyne to a point of particular interest. As is well known, dusting and spraying techniques against insect attack and plant pathogens are, like the spreading of some fertilizers, at the mercy of the wind. The wind-speed above which control becomes very difficult varies with particle-size and spreading technique; but it is usually a long way below gale force, and for finer materials may be only a few miles an hour. When the material is suspended or dissolved in water, high-pressure spraying is usually successful; but there are areas so short of water that it must be applied as a dust, and the problem arises of finding some means of making the dust stick to the plants. A heavy dew deposit will serve, and Mr. Gloyne had been asked if it would be possible to get forecasts of occasions on which early mornings of heavy dew would be followed by conditions calm enough for dusting operations to be carried out without undue loss by blowing away.

Mr. Gloyne's final remarks would be broadly accepted by most present: meteorology should be more concerned with growing food and less with getting an aeroplane from place *A* to place *B*; and an early resumption of the discussion was highly desirable.

H. L. P.

NUTRITION AND FERTILITY

THE War accentuated the difficulties of food production and the maintenance of an adequate diet for human use. Actual destruction and the diversion of human activity to destructive aims, mass movements of the population to avoid or assist military operations, and the natural increase of the population, which in spite of these disturbances continued with very little check, have brought peace-time problems of great urgency: how to maintain or raise the standard of nutrition, and at the same time make provision for the increasing population or alternatively how to control the rate of increase. Nutrition and fertility are therefore socially and economically related as well as causally connected. The emphasis of the Conference held by the Nutrition Society on March 5 was on the causal connexions, but many experiences were drawn from the social and economic spheres. Thus, Dr. G. I. M. Swyer directed attention to the apparent paradox that in the East (China, India, etc.) a high birth-rate and expanding population is associated with poverty and under-nourishment, whereas in the West adequate nourishment is associated with a stationary or declining population. Prof. A. St. G. Huggett, on the other hand, instanced the effects of starvation or near starvation on the depression of the conceptual-rate, birth-rate and birth-weight, and increase in abortion-rate and prematurity-rate, in the populations of Stalingrad and Holland during the worst periods of the War. Dr. J. Edwards showed that data collected from animal artificial insemination centres primarily concerned with increasing the milk production could be analysed to give valuable information on the effect of seasonal nutrition on bovine fertility. Dr. J. Hammond and Dr. S. J. Folley both drew inferences on the effects of nutrition on fertility from agricultural practice, and Prof. Huggett and Dr. Swyer from clinical medicine.

This approach to the subject from a wide field of generalizations necessarily brought to light the existing lack of exact knowledge on many subjects, which was particularly evident in the case of nutritional therapy. The Conference succeeded, however, not only in directing attention to gaps in our knowledge but also summarized much original and recent research.

Dr. J. Hammond, in his paper on "The Physiology of Reproduction in Relation to Nutrition", gave a very broad review. The onset of puberty is determined by factors outside the gonads; immature ovaries implanted into adult animals function immediately; mature ovaries implanted into immature animals do not function until puberty is reached. The activity of the gonad and body-growth are determined by the hormones of the anterior pituitary, and normally the onset of puberty occurs as the adult growth-rate diminishes, so that the onset of puberty must depend upon a balance of output between the growth hormone and the gonadotrophic hormones. A very high plane of nutrition may reduce the time of onset of puberty, but the weight of the animal at puberty is increased. In the mammal this may be a disadvantage by causing a diversion of nutrients from the embryo and mammary gland to the body tissues. Conversely, poor nutrition leads to delay in the age of puberty, but puberty occurs at a lower body-weight than normal. In this case pregnancy and lactation place a considerable burden on the undergrown mother. Good nutrition increases the number of ova shed. The number of ova fertilized may depend upon the viability of the spermatozoa, and there is some evidence that this is affected by the nutritional condition of the male. Development of the sheep embryo during gestation is affected by the plane of nutrition. The birth-weight and viability of lambs born to ewes underfed during the later stages of pregnancy may be seriously affected and subsequent growth retarded by deficient lactation.

Dr. A. Walton, speaking on "Spermatogenesis and Nutrition", gave an estimate of seminal output in the male and showed how this is related to the total metabolic activity of the testes. The total weekly output of semen even during great sexual activity is extremely small and cannot be regarded as a serious drain on the nutritional requirements. The spermatozoon is a highly differentiated cell in some respects, but genetic argument leads to the conclusion that the nucleus contains half the genes which are common to the somatic cells. The locomotory apparatus and metabolism are similar in most respects to muscle.

Dr. J. Edwards, on "Variations in Fertility Levels in Bovines", analysed data from insemination centres to show that although cows are fed very differently during winter and summer, the conception-rate is not significantly affected. Contrary to common expectation, the lowest rate is found to be in the quarter of the year from April to June. Bulls show no striking effects of nutrition on semen output. Dr.

S. J. Folley, on "Nutrition and Female Fertility", dealt more specifically with the causal mechanisms of nutrition. Since reproductive activity is largely controlled through endocrine mechanisms, it is to be expected that nutritional effects will act through the endocrine glands. Evidence that anterior pituitary activity is affected by nutritional factors is available. For example, rats on a restrictive diet show no œstrous cycles, but respond to injections of gonadotrophic hormones. Atrophied accessory sex organs of rats on a diet deficient in B vitamins may be restored by injection of gonadotrophic hormones. Lowered pituitary function due to inadequate nutrition may be the cause of anœstrus during winter in heifers. A direct effect of nutrition on the ovary is not established, but since the œstrogen-level in the body is due to the balance between production by the ovary and excretion, deficiencies in the excretory mechanism may lead to syndromes similar to those set up by excess œstrogen activity in the ovary. B-deficiency (thiamin and riboflavin) and diets low in lipotrophic factors may affect the efficiency of the liver to inactivate œstrogens and lead to syndromes relating to sterility, such as pathological uterine bleeding. Evidence that nutritional factors may affect the responsiveness of the tract to œstrogens is provided by Herz, who found that the oviduct of chicks fed on diets deficient in folic acid did not respond to œstrogens; 20 μgm. of folic acid daily restored normal responsiveness. Some analogous results have been found in mammals.

Prof. A. St. G. Huggett, on "Nutrition and Viable Young", dealt in detail with a more limited aspect of nutritional deficiency, namely, the placental life of the embryo. Vitamin A deficiency results in a generalized metaplasia of epithelial surfaces. In the rat there is continuous keratinization of the vagina. Usually the fœtus goes to term but dies because the birth mechanism is upset. In severe cases, however, placental death and fœtal absorption may occur. Vitamin E deficiency has no action on rats before the eighth day from copulation, that is, three days after implantation. There are parallels between the action of E deficiency and experimental embryonic trauma. In both cases changes in the placenta result from destruction of the mesoderm tissues and allantoic blood flow. The fœtus is resorbed, but the trophoblastic placenta stays in position and is delivered at term. Apparently vitamin A deficiency kills the fœtus as a secondary effect of placental death, whereas vitamin E deficiency acts mainly on fœtal hæmatopoietic organs and leaves the decidua and trophoblast intact. Riboflavin deficiency in rats may result in many congenital deformities, but this effect only occurs during the early stages of pregnancy when apparently riboflavin is essential to early ossification. An interesting parallel occurs with rubella infection, which may result in congenital cataract or heart lesions if the mother is infected in the second month of pregnancy.

Dr. G. I. M. Swyer, who discussed "Nutrition and Human Fertility", was concerned mainly with clinical diagnosis and therapy. Gross under-nourishment results in amenorrhœa and menstrual disorders and a fall in conception-rate. Over-nourishment and obesity are commonly associated with infertility in women. Recent observations by Barton and Wiesner on refractory cervical block, which is common in sterile obese women, show that the condition responds with marked success to a dietary free from sugar. The precise way in which dietary sugar brings about the syndrome of obesity, genital infection and refractoriness to œstrogens is still obscure. Successful treatment of infertility with vitamin E has been much advertised. For the male the evidence is mostly negative or statistically inconclusive. For women there is evidence that habitual abortion may be successfully treated with vitamin E.

ARTHUR WALTON

OBITUARIES

Dr. A. Cunningham

By the death of Dr. Andrew Cunningham in Edinburgh on March 4, agricultural bacteriology has lost an outstanding figure. The son of a farmer, Cunningham was born near Glenfarg on August 26, 1890. From school at Perth Academy he proceeded in 1908 to the University of Edinburgh, and after graduating in agriculture in 1911 he worked for a year in the chemistry department of the Edinburgh College of Agriculture. Deciding to study bacteriology, he spent the following winter at the Lister Institute and King's College in London, and then proceeded to Leipzig, where he worked for a year under Felix Löhnis. There, his first investigation concerned plate counts of bacteria in soil and milk, and he showed the importance of long incubation at a low temperature if maximum counts are to be obtained. In Leipzig, also, he did some of the pioneer work on the Protozoa of soil and their influence on the soil microflora. Cunningham's future career seems to have been greatly influenced by Löhnis, and it may be more than coincidence that the two men bore a remarkably strong resemblance in temperament and scientific outlook.

After working for short periods at Berne, Shinfield and Rothamsted, Cunningham joined the army in 1915 and saw active service in France. On demobilization in 1919 he was appointed lecturer in bacteriology at the Edinburgh College of Agriculture. With characteristic energy he overcame the many difficulties of building up from virtually nothing an efficient teaching department. Six years later he exchanged the lectureship for the post of adviser in bacteriology, and he at once entered with enthusiasm into the work that continued until his death. In addition to his advisory duties, Cunningham was able for several years to devote much of his time to purely scientific work on the anaerobes of soil and manures. He found that some of the butyric acid bacilli displayed a life-cycle similar to that described in *Azotobacter* by Löhnis and Smith. This work, although its findings are still controversial, ranks as the most important in his career, and it provided material for the thesis accepted by the University of Edinburgh for the degree of D.Sc. in 1931.

Cunningham's published work covers a considerable range of agricultural subjects, including the bacteriology of silage and manures, methods of examining milk, taints in milk, and the inoculation of lucerne. In recent years he had been occupied principally in an investigation of bovine mastitis, where one may easily detect his carefully devised plans, which were carried out with determination and meticulous care. His "Practical Bacteriology for Students of Agriculture", which is now in its third edition, is widely recognized as one of the best books of its kind. Abstract journals appreciated his services as a writer of concise but informative and critical abstracts.

Cunningham will be remembered as a man with a forceful personality who frequently gave expression to his strongly held opinions and acute judgments. These qualities were combined with an exceptionally wide knowledge of bacteriology. He was invariably interesting and helpful as a contributor to scientific discussions, and he was a most useful member of committees. His health had been progressively deteriorating for some time before his death. He is survived by his wife, whom he married in 1921.

T. GIBSON

WE regret to announce the following deaths:

Dr. Sydney H. Ball, mining consultant to the U.S. War Production Board, known for his work on the geology of the United States and of the Belgian Congo, on April 10, aged seventy-one.

Prof. Jules Drach, member of the Section of Mechanics of the Paris Academy of Sciences, professor of analytical mechanics at the Sorbonne, on March 7, aged seventy-seven.

Dr. A. D. Imms, F.R.S., lately reader in entomology in the University of Cambridge, on April 3, aged sixty-eight.

NEWS and VIEWS

National Chemical Laboratory of India:
Prof. J. W. McBain, F.R.S.

IT is announced that Prof. J. W. McBain, who has recently retired from the chair of physical chemistry at Leland Stanford University, California, has been appointed the first director of the National Chemical Laboratory of India. It is difficult to think of a better choice. While his many English friends have not seen so much of him since he left the University of Bristol, yet they have been able to follow his steady development of the concept of the micellar structure of colloidal electrolytes, a chapter in physical chemistry which is particularly his own. The number of papers which have emerged from Bristol and Stanford is indeed prodigious, and the world is richer for the numerous students whom he has trained. Not only are we indebted to McBain for a great extension of our knowledge of the colligative properties of these solutions, as well as conductivity and surface action, but also the behaviour of such colloidal solutions in respect to the interesting properties of emulsions and emulsion polymerization, solubilization and the like, have been fully explored by him. While his main interest has lain in this field, we must recollect that we are also indebted to him for coining the word 'sorption', thus directing attention to the complexity of the interactions between a gas and a solid, and that his treatment of the subject of adhesion in the British Association Reports still remains a classic. His many friends and colleagues will wish him well in this new and important venture.

Royal Geographical Society: Awards for 1949

HIS MAJESTY THE KING has approved the award of the Royal Medals of the Royal Geographical Society as follows: *Founder's Medal*: Prof. L. Dudley Stamp, professor of geography, London School of Economics, for his work in organising and directing the Land Utilization Survey of Great Britain and his application of geography to national planning; *Patron's Medal*: Prof. Hans Pettersson, professor of oceanography at Göteborg Hogskola, Sweden, for his leadership of the recent oceanographical cruise in the *Albatross*, in the course of which much new evidence has been obtained as to the geology of the ocean floor. The Council of the Society has made the following awards: *Murchison Grant*: Lieut.-Colonel E. H. Thompson, for original researches in the techniques of air survey, and for the development of stereoplotting machines; *Back Grant*: Dr. Brian Roberts, research fellow of the Scott Polar Research Institute, for his contributions to polar history and to the technique of polar travel; *Cuthbert Peek Grant*: Mr. A. B. Crawford, for surveys and meteorological work carried out by him at Tristan da Cunha and Marion Island; *Gill Memorial*: Dr. O. H. K. Spate, reader in geography at the London School of Economics, for his work on the geography of India and Burma.

Scientific Liaison Officer in France:
Mr. A. H. Waterfield

IN agreement with the Foreign Office, the Department of Scientific and Industrial Research has appointed Mr. A. H. Waterfield, a principal scientific officer, formerly of the Ministry of Supply, for scientific liaison duties in France, with the rank of attaché at the British Embassy in Paris. Mr. Waterfield, who is a metallurgist with special experience in the light-alloy field, was formerly on the headquarters staff of the Ministry of Aircraft Production, later the Ministry of Supply, and during the past year has been secretary of the Inter-Service Metallurgical Research Council. During 1946–47 he was attached to the United Kingdom Scientific Mission in Washington for metallurgical liaison duties.

Royal Observatory, Greenwich: Transfer to Hurstmonceux

IN the House of Commons on March 25, Mr. Hollis raised certain important points about the conditions prevailing at Hurstmonceux and also regarding the delay in assembling the instruments and in providing adequate accommodation for the staff. Mr. Hollis dealt with a number of matters that have already been emphasized by the Astronomer Royal in the Report for 1948 to the Board of Visitors and repeated by the Chief Assistant elsewhere. Mr. Hollis urged that the work at Hurstmonceux should be given an extremely high priority and pushed forward with all dispatch. The cost of the building necessary to put the new Observatory into full commission amounts to about half a million pounds, and, while admitting that such an amount cannot be treated lightly, it was pointed out that the prestige of Great Britain has been highly valued on account of the position of the meridian of Greenwich, and that there are "few matters on which such a sum could be better spent". In addition to scientific issues, Mr. Hollis raised another point—the artistic problem of Hurstmonceux. The south side of the castle presents an unsightly spectacle with a number of temporary huts of brick and wood, and although they were not placed there by the Admiralty, it was suggested that the Admiralty should remove them. Further, when permanent buildings take their place, these should be screened from the castle. He asked for a guarantee from the Civil Lord of the Admiralty that the Royal Fine Art Commission should be consulted in the matter, and made some suggestions regarding the site of these new buildings.

Mr. Hollis was strongly supported by Major Tufton Beamish, who asked for full assurances that the local authorities should be consulted in the scheme, in which they are deeply interested. The Admiralty would receive the full co-operation and all possible help from the local bodies concerned in the transfer of the Royal Observatory to Hurstmonceux. Mr. Walter Edwards, Civil Lord to the Admiralty, gave certain assurances, and stated that the Admiralty would take the Royal Fine Art Commission fully into its confidence before the second or third stage is undertaken, and also that he was prepared to consider the question of taking the local authorities completely into consultation. He thought that the Observatory would be in a proper state, counting the war period, in a little less than fifteen years, which, presumably, implies about five years from the present time. It is the fervent hope of all who are interested in scientific progress in Great Britain that this expectation will be fulfilled.

Oscar Hertwig (1849–1922)

One of the founders of the science of heredity and one of Germany's most brilliant embryologists and comparative anatomists, Wilhelm August Oscar Hertwig was born a century ago, on April 21, 1849, in Friedberg, Hessen. A pupil of Schultze, Haeckel and Gegenbaur, he graduated at Bonn in 1872, and in 1881 became professor of anatomy in Jena. Seven years later he was appointed to the chair of general anatomy and embryology at Berlin and to the directorship of the newly created Anatomical-Biological Institute. He served as rector of the University during 1904–5. Retiring in 1921, he died on October 25 of the following year, aged seventy-four. A voluminous and authoritative writer, his works (some in collaboration with his brother Richard) went through many editions and were translated into several languages, for example, his "Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere". "Die Zelle und die Gewebe" (1893) in the second edition (1906) changed its title to "Allgemeine Biologie", for the author believed that the problems of the living body could be reduced to problems of the single cell. Hertwig was one of the first to teach that the physical basis of heredity must be sought in the chromosomes. His "Cölomtheorie" (1881) helped to complete Balfour's theory of the germinal layers. Perhaps his most important achievements were his discovery in 1875 of the process of fertilization in the sea-urchin, and his observation in 1890 of the first case of parthenogenesis in the animal kingdom—in a star-fish. For a number of years he edited the *Archiv für Mikroskopische Anatomie*. It is a curious fact that the disciple of Haeckel and Gegenbaur in the end apostatized from Darwinism.

Industrial Gas Turbine Development Committee

The Minister of Supply, anxious that all possible steps are taken to ensure that Great Britain exploits to the full the industrial applications of the gas turbine, has set up a Committee to keep this matter under continuous review and to make recommendations to him as to any further research or development work which the Committee thinks should be put in hand. Sir William Stanier is chairman of the Committee, which will also include, in addition to experts from interested Government departments, a number of independent members well known in combustion engineering circles. The composition of the Committee is as follows: Sir William Stanier (chief mechanical engineer, London Midland Region, British Railways); Sir Frank Whittle (adviser on operation and development of gas turbine aircraft to B.O.A.C.); Prof. O. A. Saunders (professor of mechanical engineering, Imperial College of Science and Technology); Sir Henry L. Guy (secretary, Institution of Mechanical Engineers); Rear-Admiral (*E*) D. J. Hoare (director of research, British Internal Combustion Engine Research Association); Dr. T. W. F. Brown (director of research, Parsons and Marine Engineering Turbine Research and Development Association); F. Shakeshaft (British Electricity Authority); Dr. D. T. A. Townend (National Coal Board); A. A. M. Durrant (British Transport Commission); Dr. F. M. Birks (British Gas Council); Sir Archibald J. Gill (General Post Office); Dr. H. Roxbee Cox (Ministry of Fuel and Power); Dr. G. A. Hankins (Department of Scientific and Industrial Research); Dr. A. Parker (Department of Scientific and Industrial Research); A. E. N. Taylor (Ministry of Transport); Sir Denys C. Ford and Dr. J. A. Carroll (Admiralty); J. Anderson and A. E. MacColl (Scottish Home Department); Capt. (*E*) M. Luby, H. Constant, Lieut.-Colonel P. E. Holmes and A. P. Wickens (Ministry of Supply).

Skipton Earthquake of 1944

Dr. H. C. Versey has collected macroseismic data concerning the Skipton earthquake of December 30, 1944 (*Trans. Leeds Geol. Assoc.*, 6, No. 2; 1948), which shows that the earthquake had an intensity 7 on the Davison scale at the centre of greatest disturbance near the Gargrave Fault. In the central area subsurface drains were broken, and damage was caused to a bridge. York was just within isoseismal 5, and Lincoln, Manchester and Carlisle were within isoseismal 4. Dr. Versey relates the centre of disturbance to the Craven Faults near the margin of the rigid block of north-west Yorkshire with its early Palæozoic and possibly pre-Cambrian basement rocks. Previous shocks at Kendal (March 17, 1871), Wetherby and York may also have been connected with the faulted boundaries of this rigid block. Sound phenomena associated with the Skipton earthquake were heard by various observers, particularly those situated inside isoseismal 6, who compared the sounds with the rumbling of vehicles or the rushing of a strong wind.

University of Edinburgh

The trustees of the Godfrey Thomson Research Fund have given £5,000 to the University of Edinburgh, and promised an annual payment of £1,000 (in the first instance up to 1952) to permit the establishment of a readership in educational research, the holder of which will be largely concerned with research into problems of testing and selection. The Godfrey Thomson Research Fund draws its income from royalties on the Moray House Tests, of which the fiftieth was recently completed, and on fees from county and city education authorities for the use of tests and for statistical advice. The five trustees of the Fund, which is devoted to educational research of all kinds, but especially the improvement of intelligence and aptitude tests, are appointed by the University of Edinburgh.

University of London

The title of reader in the University of London has been conferred on the following in respect of the posts mentioned: Dr. Moses Blackman (theoretical physics, Imperial College of Science and Technology); Dr. J. McG. Bruckshaw (geophysics, Imperial College of Science and Technology); Dr. S. H. Harper (organic chemistry, King's College).

Mr. Eugene Grebenik has been appointed to the University readership in demography tenable at the London School of Economics and Political Science as from October 1, 1949.

The degree of D.Sc. has been conferred on Mr. Allan Walkley (Rothamsted Experimental Station) and Mr. F. R. Selbie (reader in bacteriology, Middlesex Hospital Medical School).

University of Glasgow

The following appointments have been made: Dr. A. M. MacDonald (from Edinburgh) to be Gardiner lecturer in pathology of diseases of infancy and childhood; Drs. R. A. Raphael (Imperial College, I.C.I. Fellow), D. S. Payne (Imperial College) and Mr. G. L. Buchanan (University of Aberdeen) to be lecturers in chemistry; R. C. Curran (Stobhill Hospital) to be lecturer in pathology at the Royal Infirmary; C. A. Hopkins (Trinity College, Dublin) to be lecturer in zoology for veterinary students; Miss A. E. Nicolson, J. S. MacPherson and R. B. Walker to be assistants in mathematics; and Dr. C. M. McLean to be an assistant in ophthalmology. Dr. G. M. Badger is resigning his I.C.I. Fellowship to become senior lecturer in organic chemistry in the University of Adelaide.

Fourth International Gas Conference

The fourth International Gas Conference of the International Gas Union will be held, under the presidency of Colonel C. M. Croft, at the Institution of Civil Engineers, Great George Street, London, S.W.1, during June 15–17. During the mornings, papers will be read, followed by discussion, dealing with many aspects of the gas industry in Great Britain, the Continent of Europe and the United States. The afternoons will be devoted to excursions to gas works and associated industries and also to places of cultural interest. Full particulars may be obtained from the Secretary of the Institution of Gas Engineers, 1 Grosvenor Place, London, S.W.1. The annual general meeting of the Institution of Gas Engineers will precede the Conference, taking place during June 13–14.

Royal Photographic Society: Officers for 1949

At the annual general meeting of the Royal Photographic Society held on March 22 the following officers were elected: *President*, Percy W. Harris; *Vice-presidents*, L. V. Chilton and I. D. Wratten; *Treasurer*, H. Abbott; *Ordinary Members of Council*, Gilbert Adams, S. W. Bowler, G. Scott Bushe, J. Allan Cash, K. H. Gaseltine, P. Hansell, Miss M. Harker, R. G. Hopkinson, T. Midgley Illingworth, J. Dudley Johnston, H. S. Newcombe, Anthony Peacock, B. Sinkinson, A. L. McR. Sowerby and H. White.

"Production of Mesons by Electrons"

Dr. I. N. Sneddon and B. F. Touschek write, with reference to their communication under this title published in *Nature* of April 2, p. 524: "The second row of the table of numerical values gives $10^4 I(E)$ and not $10 I(E)$ as stated there. The second sentence of section (3) should be amended to read: 'By analogy with *Bremsstrahlung* we might expect the cross-section for an atom with charge Z to be larger by a factor Z^2. It turns out that this factor is incorrect, since for any nucleus a competing intermediate state occurs: . . .' Further, the factors occurring in the second last paragraph should read: 'Z for positive mesons, and $A-Z$ for negative mesons'. This changes the final cross-section to 10^{-31} cm.^{2}. It has been pointed out to us by Prof. J. C. Gunn, that the 'mixed term' in the Hamiltonian of the interaction between a meson and the electromagnetic field may give rise to an appreciable correction to the values of $I(E)$. This suggestion is now being considered and will be discussed in a future publication."

Announcements

A course on the application of air photography to planning will be held at University College, London, during July 18–29 under the direction of the professor of surveying and photogrammetry (Prof. C. A. Hart). The fee for the course will be ten guineas, and full details may be obtained from the Secretary, University College, Gower Street, London, W.C.1.

The second full-day conference on combined heat and power supplies, organised by the Institute of Fuel, will be held at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, on April 27. This conference will deal with the interlinking of the heat and power systems of adjoining industrial plants, and also with the co-ordination of heat and power supplies and demands throughout a district. The conference will be open to the public, and full particulars may be obtained from the Secretary, Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1. For further consideration of general and regional aspects of the problem, the North-Western Section of the Institute is holding a conference on the same subject at the Engineers' Club, Albert Square, Manchester, on May 11.

The Department of Scientific and Industrial Research will consider applications for maintenance allowances from graduates (or equivalent) in science who wish to be trained in applied science, industrial research or technology. Such allowances may only be held in a university, institution or approved research association. Applications for the academic year 1949–50 must be made on Form 1*S* and must be completed before May 1. Full details may be obtained from the Department of Scientific and Industrial Research, Dorland House, 14–16 Regent Street, London, S.W.1.

Referring to the article entitled "Fracture of Solids" published in *Nature* of March 5, p. 376, Mr. M. W. Thring writes: "The report of Dr. Haward's observations is not quite correct in that the $\log T$, $1/S$ relation is ascribed wholly to Dr. F. W. Preston. This relation is based on Preston's work, but was published by Haward (*J. Soc. Glass Tech.*, 28, 427; 1944) prior to its independent publication by Preston (*Nature*, 156, 55; 1945)".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Inorganic Paper Chromatography

PROF. R. P. LINSTEAD kindly sent me a manuscript copy of the communication by Burstall, Davies, Linstead and Wells[1], and I should like to comment on this work in relation to my own.

Prof. Linstead and his colleagues mention that more precise separations were achieved by them by downward development; this technique was tried by me[3], but more constant R_f values are obtained by Williams and Kirby's method[4].

It is mentioned[1] that separations of gold, platinum, palladium, iridium and rhodium have been carried out by the authors. I have since devoted some more time to the platinum metals, including ruthenium and osmium, and intend to publish my results in the near future.

My results on the separation of the copper and tin groups were accepted by *Analytica Chimica Acta* on September 24, 1948, in advance of Arden, Burstall, Davies, Lewis and Linstead's first publication[2], and is at present in the press.

More recent work of mine includes the following. Silver chloride, mercurous chloride and lead chloride can be separated on a disk of filter paper by placing approximately 0·1 mgm. in the centre and adding two drops of water followed by two drops of $5N$ ammonium hydroxide as developing solvent. After exposure to hydrogen sulphide, this produces a centre patch of black mercury and mercury sulphide surrounded by a ring of silver sulphide, again surrounded by a ring of lead sulphide.

Divalent copper and cadmium can be separated by the technique described in ref. 3 by the use of 25 per cent ethyl alcohol as developer.

Divalent lead can be separated from divalent copper, cadmium and mercury, and trivalent bismuth by development with $1N$ aqueous hydrochloric acid; but the lead does not travel with the liquid front.

Using butanol saturated with $1N$ hydrochloric acid, the following R_f values were obtained:

Ion	R_f value	Ion	R_f value
Ag^{+}	0·0	Hg^{++}	1·02–1·10
Cu^{++}	0·08–0·13	Pt^{+++}	0·72–0·8
Cd^{++}	0·56–0·65	Rh^{+++}	0·07
Bi^{+++}	0·61–0·68	$RuO_4^{=}$	0·1
Pb^{++}	0·0	Ir^{++++}	0·72–0·8*
As^{+++}	0·67–0·73	Au^{+++}	1·05–1·13
Sb^{+++}	approx. 0·8*	Fe^{+++}	0·12
Sn^{++}	0·95–0·99	Co^{++}	0·07
$MoO_4^{=}$	0·5–0·53	Ni^{++}	0·07
UO_2^{++}	0·2	Mn^{++}	0·09
U^{++++}	0·0	Sr^{++}	0·0
Pd^{++}	0·6	Ba^{++}	0·0

* Further details are necessary.

Investigations with other solvents were also carried out; for example, hydrobromic, hydriodic, acetic, nitric and phosphoric acids, in butanol, etc.

On January 25, 1949, I submitted a paper to *Science* giving the details of the separation of chloride, bromide, iodide and thiocyanate ions, which is achieved by using butanol saturated with $2N$; the following R_f values were obtained:

Anion	R_f value
Cl^{-}	0·10–0·11
Br^{-}	0·15–0·18
I^{-}	0·29–0·32
CNS^{-}	0·42–0·48

For separation of smaller quantities a new technique, which I call micro-chromatography, was developed and announced to some of my colleagues in this field on December 31, 1948, in a private communication. Further details will appear in due course.

The above deals only with inorganic work. In addition, I have dealt with a number of theoretical points, including: a thermodynamical treatment of temperature variations; new aspects of 'comet' formation; generalizations concerning the effect of different anions on the R_f values of cations.

MICHAEL LEDERER

Chemistry Department,
Sydney Technical College,
Australia. Jan. 26.

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[1] [See *Nature*, January 8, p. 64.]

[2] Arden, Burstall, Davies, Lewis and Linstead, *Nature*, 162, 691 (1948).

[3] Lederer, M., *Analytica Chimica Acta*, 2, 261 (1948), received by the editors on March 20, 1948.

[4] Williams, R. J., and Kirby, H., *Science*, 107, 481 (1948).

THE spread of interest in inorganic adsorption analysis using organic solvents, indicated in Mr. Lederer's communication above and in the recent letter from Pollard, McOmie and Elbeih[1], is welcome, as it does seem that the method will have wide applications. We have tried to make its possibilities generally known both in our preliminary communications[2], by demonstrations[3], and by privately advising a number of research laboratories on applications to their individual problems.

The further development of this method may proceed along many different lines. One possibility is to compare the behaviour of a large number of different metals with standard solvents or solvent mixtures. This could conceivably lead to the separation of complex mixtures of metals in two-dimensional chromatograms, rather as has been done with amino-acids. It is interesting that both Mr. Lederer and the Bristol workers are collecting comparative data suitable for this purpose. It is, of course, necessary to bear in mind that the rate of movement of a particular metal (as represented, for example, by its R_f value) may be affected by other ions present. Another line of attack is to devise special methods for particular and more limited mixtures. Thus a group of metals can be precipitated in some standard way, and paper chromatography used as a supplementary weapon for analysis or purification. This is a line of development which we think very attractive, and one topic which we are now studying particularly is the possibility of eluting one metal after another from a paper strip or column by successive changes of the extracting medium. Separations involving some forty-five metals and anions have so far been achieved in this Laboratory. Details will appear elsewhere.

In view of the increasing interest in this subject it may be well at this stage to make a few historical matters clear. The separation of organic substances from aqueous solutions by capillary analysis was first due to Goppelsroeder[4], while it appears that H. Trey[5] achieved the first clear inorganic separations by this technique. The fractionation of inorganic compounds in aqueous solutions by means of adsorption columns was first effected by Schwab and his co-workers[6]. The great advance of the separation of *organic* compounds on paper using organic solvents was due to Martin, Gordon, Synge and their collaborators[7]. We appear to have been the first to have described the use of *organic* solvents for separating *inorganic* materials on cellulose, although it now appears that work on these lines has proceeded independently in other laboratories. Our experiments in this field began in 1946 and were described in the Annual Report of this Laboratory for 1947 [8] and in subsequent communications[2].

We did not overlook Mr. Lederer's 1948 paper[9]; but it was not referred to individually in our previous letters as it dealt with aqueous solutions. For the same reason we did not detail all the earlier work with aqueous solutions, but confined ourselves to the remarkable improvements which are possible when organic solvents are used under the best conditions.

R. P. LINSTEAD

Chemical Research Laboratory,
Teddington.

[1] *Nature*, 163, 292 (1949).

[2] *Nature*, 162, 691 (1948); 163, 64 (1949).

[3] *Nature*, 163, 235 (1949).

[4] Goppelsroeder, F., "Kapillâranalyse" (Dresden, 1910).

[5] Trey, H., *Z. anal. Chem.*, 37, 743 (1898).

[6] Schwab, G. M., and Jockers, K., *Naturwiss.*, 25, 44 (1937).

[7] Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, 37 (1), 79 (1943).

[8] Report of the Chemistry Research Board, 1947 (H.M. Stationery Office).

[9] *Analytica Chimica Acta*, 2, 261 (1948).

Mechanism of Nitration of the Aromatic Nucleus

IN order to check the constitution of preparations of the three different tritium toluenes carrying radiochemical amounts of tritium in the aromatic nucleus, samples were transformed into 2,4-dinitrotoluene with an excess of a mixture of 1 part (by volume) of concentrated nitric acid and 2 parts of concentrated sulphuric acid. An experiment in which inactive toluene was nitrated with a rather strongly active mixture of acids showed that no hydrogen exchange takes place under the conditions of the reaction. No activity could be detected in the dinitrotoluene, though it had been possible to record an acquired tritium : protium ratio as small as 1 per cent of that of the surrounding mixture of acids and water, even if only one of the organic hydrogen atoms had taken part in the exchange.

It was to be supposed that on dinitration toluene-4-t would lose all, and toluene-3-t none, of its activity. Toluene-2-t, finally, would lose an amount corresponding to the relative velocities of nitration in the two ortho positions, carrying tritium and protium, respectively.

The different organic molecules were burnt and the specific activities of the water samples determined[1]. In the calculation of the percentage of tritium remaining in the molecule after nitration, the different hydrogen contents of toluene and its dinitro derivative were taken into account. The accompanying table gives the results.

In the case of toluene-4-t some other isomer seems to have been present in the sample.

In the case of toluene-2-t, both experimental figures equal 50 per cent just within the experimental error, which implies that the nitration proceeds with very nearly the same velocity irrespective of whether tritium or protium originally occupies the position. In view of the great difference in mass (and therefore in the zero point energy of the original bond, the difference in which, however, may be more or less counterbalanced by a similar difference of the same magnitude in the 'activated complex' of the reaction, particularly if a base enters the complex[2]), it seems natural to suppose that the velocities should be different if the splitting off of the hydrogen takes part in the rate-determining step of the attack on the nucleus (which is not necessarily that of the reaction as a whole). Since there is no exchange of hydrogen with the acids and the water, the reason cannot be the existence of a dissociation equilibrium. The simplest way of accounting for the present observation seems to be the assumption of an addition of the nitrating agent (NO_2^+) [3,4] as the rate-determining step, followed by a rapid splitting-off of the hydrogen. The intermediate ion might have a quinonoid character.

Substance nitrated	Percentage of original tritium still present in the 2,4-dinitrotoluene	
	Theoretical	Observed
Toluene-4-t	0 per cent	2·2 per cent
Toluene-3-t	100	99·0
Toluene-2-t	(50)[*]	51·9; 49·7 (two exp.)

[*] On the assumption of equal nitration velocity in tritium and protium positions.

LARS MELANDER

Nobel Institute for Physics,
Stockholm 50. Oct. 25.

[1] Melander, L., *Acta Chem. Scand.*, 2 (in the press).

[2] Bennett, G. M., Brand, J. C. D., James, D. M., Saunders, T. G., and Williams, G., *J. Chem. Soc.*, 474 (1947).

[3] Bennett, G. M., *et al.*, several papers in *J. Chem. Soc.*, 1946 and 1947.

[4] Ingold, C. K., *et al.*, several communications in *Nature*, 158 (1946).

Kinetics and Mechanism of Aromatic Nitration

IN an earlier note[1] it was shown how the study of the kinetics of nitration, particularly the study of reaction order, established (*a*) the formation of the nitronium ion, and (*b*) its effectiveness as the entity which attacks the aromatic molecule. Further kinetic investigation, particularly of salt and solvent effects, has given information on two other general features of the reaction. They relate to (*c*) the reaction stages by which the nitronium ion is formed, and (*d*) those by which it becomes a nitro-group in the aromatic compound.

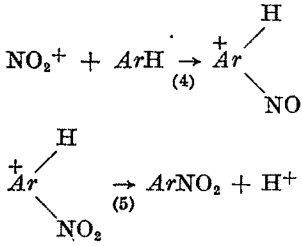
(*c*) The stages by which the nitronium ion is formed may be discovered by reference mainly to conditions in which the rate of nitration is equal to the rate of formation of the nitronium ion. For the formation of nitronium ion from nitric acid, the stages are as follows:

$$2HNO_3 \underset{(2)}{\overset{(1)}{\rightleftharpoons}} H_2NO_3^+ + NO_3^- \qquad \text{(1 and 2 fast)}$$

$$O_2N\cdot\overset{+}{O}H_2 \underset{(3)}{\rightarrow} O_2N^+ + OH_2 \qquad \text{(3 slow)}$$

The proof of this rests on a hyperbolic repression by nitrate ions of the rate of nitration ($v \propto c^{-1}$), without disturbance to the reaction order, even when it is of zero order. Other sufficiently strong acids, such as sulphuric acid, may replace one molecule of nitric acid in providing the proton required for the formation of the nitric acidium ion, as illustrated in (1).

(*d*) The stages by which the nitronium ion enters the aromatic ring are elucidated by reference mainly to conditions of nitration in which the nitronium ion is rapidly formed. The transformation of the nitronium ion into an aromatic nitro-group is a two-stage bimolecular process, the proton-loss having no kinetic significance:



$$NO_2^+ + ArH \xrightarrow{(4)} \overset{+}{Ar}(H)(NO_2) \qquad (4\ slow)$$

$$\overset{+}{Ar}(H)(NO_2) \xrightarrow{(5)} ArNO_2 + H^+ \qquad (5\ fast)$$

This follows because the solvent effect, under the conditions indicated, is small enough to show that ionic charges are neither formed nor destroyed in the rate-determining stage of the entry of the nitronium ion as a nitroxyl group into the aromatic molecule. The alternative possibility, that the reaction is a one-stage termolecular process, in which the proton-loss is kinetically important, requires the reaction to be base-accelerated, and therefore, since the strongest available bases are nearly always anions, requires ionic charges to be destroyed; for example:

$$NO_2^+ + ArH + SO_4H^- \xrightarrow{(6)} ArNO_2 + H_2SO_4.$$

Reaction (6) should be comparable to (2), or in an inverse sense to (1), in solvent sensitivity, and this the reaction between nitronium ions and aromatic molecules certainly is not. Reaction (4) should show a small solvent effect due to the spreading of the charge in the transition state; and the actual reaction does, indeed, exhibit such an effect.

We were commencing an investigation, in which we expected to confirm the kinetic insignificance of the proton-loss by showing that aromatic protium and deuterium are replaced by nitroxyl at the same rate, when Dr. Melander very kindly sent us word that he had just completed such a demonstration, but using tritium rather than deuterium. His work is conclusive (see preceding communication).

The effect of small amounts of water in accelerating nitration in sulphuric acid has been interpreted[2] as a mass-law effect on the basis of (6). We think that the phenomenon which in the simplest circumstances comes under observation here is the small solvent effect on (4). From the dielectric properties of sulphuric acid, and its behaviour in solvating cations, it seems certain that the first effect of added water must be to reduce solvating power, and thus to create a kinetic effect in the observed direction[3]. Actually a complication enters in nearly all real cases, as has already been pointed out[4]. It is that most substances of which the nitration-rates in sulphuric acid have been studied combine with the acid to form unreactive salt-like complexes, which added water will partly break up, thereby facilitating nitration. But when this effect is negligible or absent, the solvent influence on (4) remains as a factor which will cause a small initial acceleration by added water.

R. J. GILLESPIE
E. D. HUGHES
C. K. INGOLD
D. J. MILLEN
R. I. REED

Sir William Ramsay and
Ralph Forster Laboratories,
University College,
London, W.C.1.

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[1] Hughes, Ingold and Reed, *Nature*, 158, 448 (1946).

[2] Bennett, Brand, James, Saunders and Williams, *J. Chem. Soc.*, 474 (1947).

[3] Gillespie, Hughes and Ingold (forthcoming papers).

[4] Gillespie and Millen, *Quart. Rev. Chem. Soc.*, 2, 277 (1948).

Monolayers of Collagen

PAST work on monolayers of gelatin on water has generally led to the conclusion that it is not suitable for such studies because of its high solubility[1]. This difficulty has been overcome with other proteins by spreading on strong solutions of ammonium sulphate[2], and we have found that stable monolayers of collagen can be formed on 30 per cent ammonium sulphate solution (*p*H 4) by spreading from formic acid solution. The surface pressure (π) and surface potential (ΔV) have been studied over a pressure-range of 0·01–30 dynes/cm. When the area (A) is greater than about 5 m.^{2}/mgm. the film is heterogeneous, large fluctuations of ΔV being observed as the ionizing air-electrode is moved over the surface, although no constant surface vapour pressure was found. As the film is compressed to areas smaller than about 5 m.^{2}/mgm. it becomes homogeneous and $\Delta V.A$ is constant. On further compression, two critical areas are recognized: (1) A_1 (1·8 m.^{2}/mgm.), below which values of $\Delta V.A$ fall, indicating a change in orientation, accompanied by a decrease in compressibility; (2) A_2 (1·3 m.^{2}/mgm.), which is derived by extrapolating the linear portion of the π—A curve (between 1·0 and 0·2 m.^{2}/mgm.) to zero pressure.

We suggest that these two areas correspond to close-packing of the polypeptides with their side-chains orientated (*a*) parallel to, and (*b*) perpendicular to the water surface. From existing data on the amino-acid composition of collagen[3], these areas are found to correspond to about 27·5 and 20 A.^{2} per mean residue, respectively. Calculations based on the mean side-chain length and Astbury's mean repeat distance of 2·85 A. for collagen give a value for A_1 of 28·2 A.^{2} per mean residue, assuming that ends of the 'mean' side-chains approach to within the H—H covalent bond distance. The determined value for A_2, of 20 A.^{2}/mean residue, is very near that for close-packed fatty acids, amides, etc., with the side-chains practically vertical. This area has been observed with several other proteins (for example, Philippi[4]). Compression to areas smaller than A_2 must result in the displacement or solubilization of parts of the film.

When collagen was spread on solutions of hydrochloric acid and sodium chloride, stable and reproducible films were formed when the film was initially spread at areas larger than A_1. Poor reproducibility resulted when the initial area was less than A_2. By studying the π—A curves over a range of *p*H values and salt contents, the following two distinct phenomena are apparent:

(1) At areas larger than A_1, the π—*p*H curves at constant area show a maximum at *p*H 2·2, sodium chloride causing the maximum to be depressed and, when present in sufficient amount, to disappear (see Fig. 1).

(2) At areas smaller than A_2, the π—*p*H curves show no maxima whether or not salt is present, π increasing as the ionic strength of the solution increases, that is, as the *p*H decreases (see Fig. 2). None of the π—A curves gives a linear portion which can be extrapolated to zero pressure.

At areas greater than A_1, where the molecules are probably orientated with the side-chains parallel to the surface, the dependence of the two-dimensional osmotic pressure (π) on *p*H and salt is similar to that predicted by the three-dimensional Donnan theory, or by consideration of the electrical properties of the film

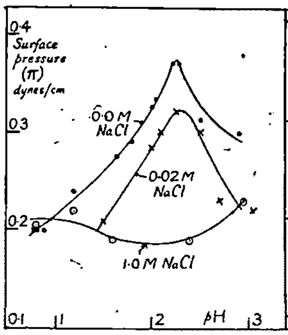

Fig. 1. Area = 2·5 m.²/mgm.

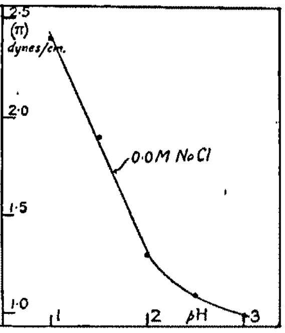

Fig. 2. Area = 0·5 m.²/mgm.

as deduced by Philippi[4] from the Gouy–Chapman treatment of the ionic distribution in the electrical double layer. At areas smaller than A_2, where it is impossible for all the film to remain in the surface, the action of both acid and salt appears to be that of 'salting-out' agents, the increasing ionic strength necessitating more work to cause displacement.

Our thanks are due to the Director and Council of the British Leather Manufacturers' Research Association for permission to publish this communication.

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Measurement of the Elasto-Plastic Properties of Gels

Cheftel and Mocquard[1] used the deflexion of a vane embedded in a gel to record the relation between the deformation of the gel and the applied force.

Goldsmith and Iball[2] showed that, if the vane is attached to a torsion wire and deflected by an angle δ with the torsion head turned through an angle α, the blade deflexion at time t is given by

$$\ln \{\alpha/(\alpha - \delta)\} = Ct^k/\Psi, \qquad (1)$$

where C is a constant of the instrument, Ψ a constant of the gel denoting its firmness and k the dissipation coefficient. Equation (1), which thus permits calculation of the 'firmness intensity factor' Ψ, was found to be applicable to a number of different milk curds for which the index β of the applied stress was unity and where the elastic limit was exceeded at a negligibly small applied stress.

Further experiments have shown that the torsion method can also be used to find the rheological properties of gels which possess considerable elasticity. In this case, the apparent 'firmness intensity factor' is composed of an elastic and plastic component, the former being independent of time and thus determined by the shear strain at $t \simeq 0$, whereas the latter is dependent on the relation between shear strain and time at $t > 0$. A modification of equation (1) is thus necessary to account for the elasticity of the gel, the modified equation taking the form:

$$\ln \{\alpha/(\alpha - \delta)\} = C(1/E + t^k/\Psi), \qquad (2)$$

where E is the modulus of elasticity.

The following figures were obtained by means of equation (2) for the gels formed by 1 per cent solutions of commercial soaps at 25° C. ($\beta = 1$).

Sample	E (dynes/cm.²)	ψ (C.G.S. units)	k
I	7·0	261	0·590
II	27·1	172	0·402
III	42·7	78·5	0·256

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Volatility of the Oxides of Tungsten and Molybdenum in the Presence of Water Vapour

According to L. Wöhler and O. Balz[1,2], the oxides WO_3, W_2O_5 (W_4O_{11}) and WO_2 volatilize considerably above 800–900° C., and the vapour pressure of tungsten trioxide is, according to O. Ruff and Grieger[3,2], 0·206 mm. at 1,023° C. It is generally believed that this phenomenon explains the formation of much larger metal grains during the reduction of tungsten trioxide in hydrogen at 800–900° C. from much finer oxide grains.

Our experiments have, however, shown that the known oxides, WO_3, W_4O_{11} and WO_2, do not sublime at an appreciable rate under 1,000° C. either *in vacuo* or in a stream of a neutral gas. For example, 0·5 gm. of any of the oxides in a quartz tube at a pressure of 1/1,000 mm. gave only insignificant traces on the cold part of the tube during 58 hr. at 1,000° C., and only 1–5 mgm. during 8 hr. at 1,300° C. Similarly, less than 0·5 gm. volatilized at 1,000° C. during 1 hr. of the same quantity of WO_3 in a stream of oxygen (velocity 100 l./hr./2 sq. cm.) and an even smaller quantity of W_4O_{11} or WO_2 in a stream of purified argon (velocity 10 l./hr./2 sq. cm.).

The known oxides of tungsten volatilize, however, readily at 1,000° C. at a pressure of 1 atm. in the presence of water vapour (see Table 1).

This table clearly indicates that, under these conditions, the sublimation of WO_3 in moist air, oxygen

Table 1

1 atm., 1,000° C.							
	Carrier gas	Water (vol. %)	v, streaming velocity (l./hr./2 sq. cm.)	Time (hr.)	Weight of oxide (mgm.)	m, sublimed mass (mgm.)	k
WO_3	Oxygen	0	100	1	470	0·3	—
		0·4	100	1	490	1·2	30
		2	4	1	460	1·6	40
		29	113	1	470	120·6	39
		75	40	1/2	480	70·5	30
		100	30	1/2	470	81·3	30
W_4O_{11}	Argon	0	10	1	510	0·1	—
	Hydrogen	86	34	1/2	540	63·3	24
WO_2	Argon	0	10	1	330	0	—
	Hydrogen	59	41	1	140	39·6	37

or water vapour, of W_4O_{11} in a mixture of hydrogen and water containing 64–94 per cent water, and lastly of WO_2 in a mixture of hydrogen and water containing 49–64 per cent water (both mixtures assuring an invariant composition of the W_4O_{11} and WO_2 respectively[4]), is so rapid that during a few hours a substantial deposit would be produced. The speed of sublimation (the material volatilized in an hour) can be expressed with the notation of Table 1 approximately as follows :

$$m = k \text{ (vol. per cent) } \sqrt{v}.$$

The deposited WO_3 is a greenish-yellow crystalline powder, the W_4O_{11} crystallizes mainly in violet needles, and WO_2 gives a gold-brownish mirror of metallic lustre.

Searching for similar effects with the oxides of other metals, it was found that water vapour is capable of enhancing—if only to a smaller extent—the volatility of molybdenum trioxide (MoO_3) also (see Table 2).

Table 2

	Oxygen, 1 atm.					
	Water (vol. %)	v, streaming velocity (l./hr./2 sq. cm.)	Temperature (t °C.)	Time (hr.)	Weight of oxide (mgm.)	m, sublimed mass (mgm.)
MoO_3	0	80	600	1/2	892	0·5
	66	59	600	1/2	880	8·5
	0	80	700	1/2	892	15·0
	66	59	700	1/2	870	92·3

The sublimation of the above-mentioned oxides is therefore interesting, for WO_3, the hydrate of composition of which, WO_3H_2O, decomposes entirely when heated to 300° C., in its solid phase is unable to combine with more water molecules at higher temperatures, but can, however, easily combine with the water present in the gaseous phase. This phenomenon cannot be regarded as a water vapour-distillation, because there is no liquid phase. It must be emphasized that it is the oxides themselves which condense from the gaseous phase and not a hydrate. So it seems that the water molecules can form bonds in the gaseous phase strong enough to dislodge the oxides from the crystal lattices. We are of opinion that the generally known tendency of the W^{6+} and W^{4+} ions to be octahedrally co-ordinated[5,6,7] with $O^{=}$ favours the formation of separate molecules (for example, $WO_3.3H_2O$, etc.) in the gas, in contrast with the distorted octahedrons found in their lattices[5,6].

This property serves to explain C. J. v. Nieuvenburg and H. B. Blumendal's observation[8], who have found that solid tungsten trioxide can be dissolved in water vapour near the critical region, at 380° C., at 275 atm. Similarly, the pneumatolytic origin of tungsten ores can be accounted for; and the suggestion of the dominant role of water vapour near the critical pressure appears superfluous, for these ores can be formed at atmospheric pressure, too.

The sublimation of the oxides of molybdenum and tungsten can be used for analytical purposes and for the purification of the oxides. Tungstates cannot be attacked by water vapour.

The above investigations clearly indicate that it is not the spontaneous volatility of the tungsten oxides, but the volatility induced by water vapour, which is the main factor of the phenomenon, thoroughly investigated in the incandescent lamp industry, that by reduction with hydrogen the fine tungsten trioxide gives a much coarser metal powder.

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Mechanism of the Fischer Indole Synthesis

Sir Robert Robinson (private communication) has commented that our interpretation[1] of the cyclizations of mixed hydrazones may be more simply explained by assuming that the hydrazones may be hydrolysed initially in glacial acetic acid medium, and then the free phenylhydrazines and *cyclo*hexanones recombine to form the different tetrahydrocarbazoles mentioned (*loc. cit.*).

Although it has not been possible to investigate this criticism completely, nevertheless it has been found by us that, when the *o*-tolylphenylhydrazone of *cyclo*hexanone is cyclized in glacial acetic acid in the presence of phenylhydrazine, appreciable quantities of carbazole can be obtained after dehydrogenating the product.

This indicates that the above criticism is very pertinent, and that our interpretation is only one of the alternatives. Further investigation is in progress.

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A Method of Mounting Filamentous Materials for Spectroscopic Examination in the Infra-Red

Spectroscopic examination of filamentous materials in the infra-red has hitherto been far from easy owing to the difficulty of obtaining a satisfactory specimen mount. A twisted bundle of filaments cannot be used, partly because the effective thickness of such a sample is generally excessive, and partly because the amount of radiation scatter which it produces is far too great. For nylon filaments these difficulties have been overcome by the use of the mount described here.

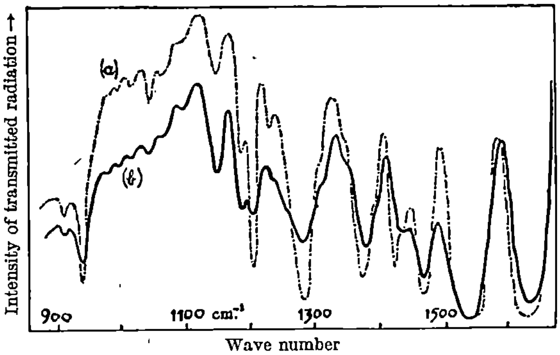
The device consists essentially of two rectangular U's, made from ⅛-in. carbon steel plate, between which is a strip of thin metal spacer foil, the plates being clamped together by means of two countersunk screws tightening into tapped holes in one of the plates. The gaps between the limbs of the U's are each ⅜ in., that is, slightly less than the length of the spectrometer slit. The inside faces of the plates are carefully ground and lapped flat so that they will stick together by mutual cohesion. The tips of the U's are given a slight chamfer so that the filaments may be inserted more easily. The thickness of the spacer foil should be one or two ten-thousandths of an inch less than the diameter of the fibres to be mounted.

In preparing a specimen it is convenient to clamp the mount to a glass plate and place it in the field of view of a binocular microscope. Single filaments, 4–6 in. in length, are then inserted one by one into the slots, bringing the first right up to the edge of the spacer metal and packing each succeeding filament as closely as possible to the last. Adequate packing can be obtained by inserting periodically a second strip of spacer metal into the jaws of the mount, using this to press the filaments closely together. Each filament can be held after mounting by embedding its ends in lumps of 'Plasticine' on the glass plate.

The number of filaments that must be mounted in this way will depend on their diameter and on the spectrometer slit width; for nylon filaments 0·008 in. in diameter it is sufficient to mount 40–50. When the required number have been placed in position, a final piece of metal foil is inserted to help preserve the alignment of the mounted filaments, and also to prevent any radiation passing directly into the spectrometer around the edges of the grid in the event of the specimen being moved while measurements are in progress.

The filaments are then stuck down to the outside edges of the steel plate by a thick cement, after which the cemented portion is covered with transparent adhesive tape. The loose filament ends and the protruding ends of the spacer metal are trimmed off.

The radiation scatter from the filaments so mounted is not excessive, and the effective thickness is low enough to allow reasonably small slit widths to be used, so that satisfactory spectra can be obtained from it directly. If desired, however, the scatter can be reduced by moistening the filaments with 'Nujol', and placing a small rock-salt window on each side, holding the windows in position by a small brass clamp.



A comparison of the instrumental records obtained from (*a*) a nylon film and (*b*) a grid of nylon filaments. (*a*) Nylon film, 20 μ thick; spectrometer slits 0·3 mm. (*b*) Grid of 20 μ diameter filaments: spectrometer slits 0·4 mm.

In the accompanying drawing, the transmitted radiation obtained from a filament grid (continuous line) is compared with one from a nylon film (broken line). For the grid, composed of filaments 20 microns in diameter, the spectrometer slits were set at 0·4 mm.; for the film, 20 microns thick, the slits were 0·3 mm. wide.

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Measurement of Small Surface Angles

IT has been established that multiple-beam fringes of equal chromatic order are particularly sensitive for the evaluation of small surface angles. Yet they suffer from a disadvantage in that the angle shown by the fringes depends upon the orientation of the surface relative to the spectrograph slit. In fact, a resolved component of any surface angle appears, and in general it is necessary to rotate the surface under observation to find the maximum corresponding to the true surface angle.

This difficulty can be avoided by the combined use of superposition of fringes of equal chromatic order with Fizeau fringes, on the same photographic plate, as follows. Consider a simple wedge between two planes, one vertical with the edge perpendicular to the spectroscope slit. This leads to the formation of a family of fringes of equal chromatic order the shape of which depends upon the wedge angle and the spectrograph dispersion. If y_1 is the vertical distance between two fringes, then the wedge angle is $\tan^{-1} \lambda_1/2y_1$. However, in the general case the edge of the wedge is not perpendicular to the slit, and if φ is the angle made by the edge and the slit, then the true angle of the wedge θ is given by the relation $\tan \beta = \tan \theta \sin \varphi$, where β is the apparent angle given by the fringes of equal chromatic order, that is, $\tan \beta = \lambda_1/2y_2$, when y_2 is the vertical distance between two fringes. However, the Fizeau fringes from a wedge are straight lines parallel to the edge; hence the angle φ is simply the angle made by the Fizeau fringes with the slit, that is, with any spectral line. Clearly a superposition of the two systems enables φ to be measured.

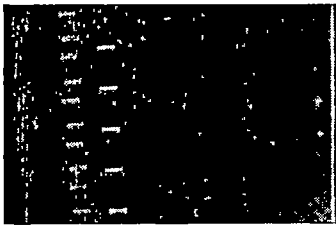

Fig. 1

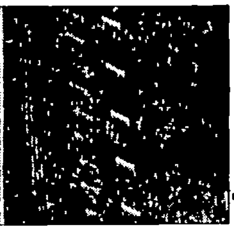

Fig. 2

This is obtained very easily in practice. The narrow fringes of equal chromatic order are first photographed with the usual source of white light, using a narrow slit. Without moving either the interference system or photographic plate, the slit is opened wide and the source of white light replaced by a mercury arc. Fizeau fringes are thus superposed on the fringes of equal chromatic order, as shown in Fig. 1. This is the special case of a wedge set with $\varphi = \pi/2$, and the Fizeau fringes are horizontal. The Fizeau fringes assist in identifying the intercept of a vertical line with successive fringes of equal chromatic order. In the case shown $\tan \theta = 0·001$.

Fig. 2 illustrates the appearance when the wedge happens to be set with $\varphi = 60°$, and it is easy to see how the formula given above enables θ to be derived. Even with such low dispersion, the angle calculated from Fig. 2 agrees with that from Fig. 1 to within about 1 per cent.

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Quantitative Researches on the Optical Properties of Human Bone

THE quantitative studies of Dallemagne and Mélon[1] on the optical properties of ox bone (already described in part in *Nature*[2]), and their deductions concerning the relations between the organic and the inorganic fractions of the bone, have led me to a series of analogous, independent researches on human bone.

In specimens from subjects three to sixty years old, the index of refraction at room temperature of air-dried human bone (femoral diaphysis) was found to be almost constant and ranged around 1·560 ± 0·002. From birth until the age of three years, the index of refraction appears to rise at an increasing rate from 1·549 to 1·560. In the seventh and eighth decades, there is a small but noticeable increase: 1·564 ± 0·002. Bone from which the organic fraction has been removed shows a particularly interesting behaviour which to my knowledge has not been pointed out before: the index of refraction estimated by the methods of Becke and Schröder van der Kolke varies in value according to the nature of the comparison fluids. A value of 1·600 ± 0·002, almost constant for all ages, is obtained by using a mixture of oil of lavender and oil of cinnamon, which in all probability gives results more closely approximating the real values. Technical difficulties do not allow precise measurements of the index of refraction of fresh bone or of bone deprived of its mineral fraction. However, it is probable that the index of refraction of fresh bone from adult subjects is not less than 1·540.

The birefringent power of normal human bone ranges about + 0·004, as determined from measurements on seven subjects of 1, 3, 7, 11, 25, 50 and 80 years of age.

The quantitative researches clearly agree with the fact, already observed qualitatively by Schmidt[3], that normal human bone, deprived of its organic fraction, follows Wiener's law[4] of birefringence of form (*Formdoppelbrechung*). The parabolic curve of birefringence of form has a negative vertex. It follows from this that the mineral fraction of the bone is anisotropic and has its own negative birefringence (*Eigendoppelbrechung*). With due reservations on the more or less perfect penetration of the fluids in bone deprived of its organic fraction, the birefringent power of the mineral fraction is not constant, but varies with the age, tending to diminish rapidly in the first years of life, while remaining practically stationary during adult and old age.

The conclusions which Dallemagne and Mélon[1] wish to draw from their researches on the optical properties of ox bone, namely, "La fraction organique de l'os, représentée par l'osseine, n'accuse . . . aucun lien chimique perceptible aux méthodes physiques avec le phosphate tricalcique, élément principal de la fraction minérale", do not seem to me acceptable without reserve, and this for two fundamental reasons: (1) A chance coincidence may be responsible for the identical values obtained by these authors for the total birefringence measured directly and for the indirectly calculated birefringence. Indeed, the index of refraction and the relative volume of the organic substance measured by Dallemagne and Mélon do not apply only to the fundamental interfascicular substance (*Kittsubstanz*) to which the mineral fraction is bound, but rather to the complex mass consisting of fundamental substance + collagen fibres. (2) Dallemagne and Mélon also do not take into consideration the birefringence of the organic substance (fundamental substance + fibres), which certainly has an influence on the value of the total birefringent power of the bone.

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Synthesis of γ-Glutamyl Peptides

IN the classical synthesis by Bergmann and Zervas[1], carbobenzoxy L-glutamic anhydride reacts with amino-acid esters to yield, after saponification and hydrogenation, α-glutamyl peptides. There have, however, been indications that the anhydride ring may not open exclusively in this direction. Bergmann[2] reported that glycylglycine ethyl ester yields a mixture of the α- and γ-derivatives, and in the analogous reaction with ammonia Melville[3] found some 14 per cent glutamine admixed with the *iso*-glutamine. Anomalies have also been observed in the opening of the ring of carbobenzoxy L-aspartic anhydride[4].

In the course of an investigation of ring openings of this type, we have examined the reaction of carbobenzoxy L-glutamic anhydride with cold aqueous hydrazine. The crystalline product, isolated in nearly quantitative yield (m.p. 170–171°), was found to be a mixture of the α- and γ-hydrazides, which could not be separated by repeated crystallization. Conversion to the azide and coupling with glycine ethyl ester gave a product from which carbobenzoxy α-L-glutamyl glycine could be isolated in low yield, but which on saponification and hydrogenation gave a mixture of α- and γ-peptides, since with ninhydrin 0·8 moles of carbon dioxide were evolved.

We were therefore led to prepare pure carbobenzoxy γ-L-glutamyl hydrazide by the action of hydrazine on the carbobenzoxy γ-ethyl-L-glutamate of Abderhalden and Nienburg[5]. This hydrazide, which clearly should provide an unambiguous path for the synthesis of γ-glutamyl peptides, has recently been described by Hegedüs[6], who has demonstrated its usefulness in a novel synthesis of glutathione. We record, however, m.p. 178–179° (uncorr.) for our carbobenzoxy γ-L-glutamyl hydrazide, which we obtained in quantitative yield on treating the ester with hydrazine in aqueous ethanol at 20° for 48 hours (found: C, 52·7; H, 5·9; N, 14·0; $C_{13}H_{17}O_5N_3$ requires C, 52·86; H, 5·81; N, 14·23 per cent. $[\alpha]_D^{18}$ − 13·4° ± 0·4° in 0·5 *N* hydrochloric acid, *c*, 6·4; $[\alpha]_D^{18}$ − 5·1° ± 0·3° in water containing 1 equiv. NaOH, *c*, 10·0). Hegedüs records m.p. 170–172° (uncorr.), and 44 per cent yield.

Our carbobenzoxy γ-L-glutamyl hydrazide yielded a benzylidene derivative, m.p. 200–201° (found: C, 62·5; H, 5·7; N, 11·2; $C_{20}H_{21}O_5N_3$ requires: C, 62·64; H, 5·52; N, 10·96 per cent). Conversion to the azide and coupling with glycine ethyl ester in chloroform solution gave carbobenzoxy γ-L-glutamyl glycine ethyl ester, m.p. 107–109°, which was saponified to carbobenzoxy γ-L-glutamyl glycine, m.p. 159–161° (found: C, 53·5; H, 5·3; N, 8·3; $C_{15}H_{18}O_7N_2$ requires: C, 53·24; H, 5·37; N, 8·28 per cent). Hydrogenation gave γ-L-glutamyl glycine, m.p. 193–194° (found: C, 41·5; H, 5·9; N, 13·7; $C_7H_{12}O_5N_2$ requires: C, 41·17, H, 5·93; N, 13·72 per cent. $[\alpha]_D^{14} + 11 \cdot 1° \pm 0 \cdot 8°$ in water, c, 2·5).

Partition chromatography on paper (using phenol saturated with water as the mobile phase) confirmed the purity of the γ-L-glutamyl glycine, in so far as only one component was revealed by ninhydrin. With the latter reagent at pH 2·5 and 100°, 1·0 mole of carbon dioxide was evolved, confirming the presence of a free α-amino-acid group.

These investigations are being continued and extended to the aspartic acid analogues. We are grateful to the Government Grants Committee of the Royal Society for financial assistance.

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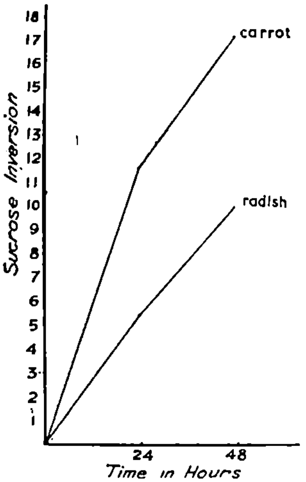
Comparative Study of Sucrose Inversion and Synthesis by Carrot and Radish Root Slices

In previous papers[1,2], it has been established that when radish or carrot root slices were suspended in sucrose solution, the latter was always inverted in the medium before its absorption by the tissue slices, and the inversion was always faster than the uptake, hence the accumulation of invert sugar in the culture medium. Gawadi[3] and Burström[4] showed that sucrose inversion takes place by means of invertase centres attached to the outer cytoplasmic surfaces of cells of the slices. Saïd[1] found that when slices of varied thicknesses were suspended in sucrose solution, the rate of inversion in the medium was directly proportional to the number of exposed surfaces per mass of tissue slices.



Total sucrose inversion in the culture media of equal numbers of carrot and radish root slices having the same diameter

We carried out several experiments in which 1-mm. thick slices of carrot and radish roots, having the same diameter, were suspended in sucrose solutions. Comparing the rates of sucrose inversion by equivalent numbers of slices of both roots, it was found that the rate of sucrose inversion by carrot slices was always much faster than that by radish slices (see accompanying graph). This observation leads to the conclusion that the number of active invertase centres on the outer cytoplasmic surfaces of radish is less than on equivalent surfaces of carrot.

Analysis of the sugar-fed slices from these two plants showed further that carrot slices always build up sucrose from any absorbed sugar whereas radish slices form but little sucrose from the absorbed sugars, the accumulation being always in the form of hexoses.

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Coagulation of Oxalated Plasma Without Calcium Following Neutralization of Heparin by Toluidine Blue

Under physiological conditions, calcium is necessary for the coagulation of blood, because with thromboplastin it brings about the change of prothrombin into thrombin. But the true role of calcium ions has not hitherto been understood. On the other hand, this change is inhibited by heparin in connexion with a plasmatic co-factor, which was determined as an acid-soluble albumin[1]. The anticoagulating influence of heparin is specifically inhibited by toluidine blue[2]. We have used this property of toluidine blue to examine the function of the heparin which in normal circumstances is present in the blood. The influence of the physiological amount of heparin on blood coagulation is still under discussion. The complex heparin–plasma co-factor inhibits the action of thromboplastin on the change of prothrombin to thrombin[3]. We are putting forward the working hypothesis that the interaction between the heparin complex and thromboplastin of plasma is the cause of the fluidity of blood in the vessels, and that calcium in some way either with a tissue extract or otherwise neutralizes the heparin complex. If this assumption is correct, the toluidine blue will coagulate the decalcified plasma.

Oxalated pig plasma was used, and the point of coagulation determined in a water bath at 37° C. Toluidine blue was added in the isotonic Michaelis veronal buffer with sodium chloride in various concentrations. Fig. 1 shows the rate of coagulation of plasma induced by toluidine blue without recalcification. Further, we found that the clotting time under the influence of toluidine blue (curve *A*, Fig. 2) depends on the dilution of the plasma in a similar

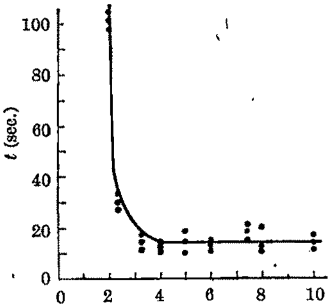

Fig. 1

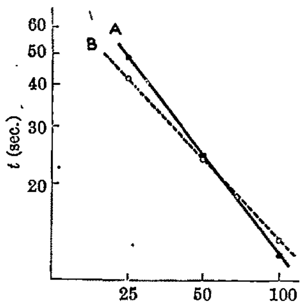

Fig. 2

proportion as in the case of the coagulation with thromboplastin and calcium (curve *B*, Fig. 2).

These experiments show that it is possible to produce coagulation of decalcified plasma without addition of calcium by adding toluidine blue only. The preformed plasma–thromboplastin is active enough to produce coagulation of the blood if the action of the heparin complex is inhibited by toluidine blue. The heparin present in blood takes part also in the blood-clotting process, and the role of that physiological amount of heparin seems to be to maintain the fluidity of blood in the vessels.

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Nature of a Muscle-Inhibiting Compound in Lucerne and its Possible Connexion with Bloat in Cattle

IN an earlier note[1] attention was directed to the muscle-inhibiting power of clover juice and a possible relationship between this action and the disturbance known as bloat, or hoven, in cattle. Further work on a variety of herbage plant juices has confirmed the early findings[2], and has led to the separation from lucerne juice, purification and probable chemical identification, of a substance capable of inhibiting muscle movement.

Hydrocyanic acid can cause smooth muscle paralysis, and undoubtedly some acid is produced in the rumen of cattle grazing legumes, by the hydrolysis of cyanogenetic glycosides. South African workers[3], however, failed to incriminate hydrocyanic acid as a cause of acute bloat, but it should not be ruled out as one of possibly several aggravating or supplementing factors. This aspect has received attention at Aberystwyth[4].

The compound we have isolated from lucerne, by ether extraction of clarified juice, is a pale-yellow crystalline substance which, after repeated crystallization, strongly inhibits muscle action. Chemical and physical examination has shown it to be a flavone, and, subject to final confirmation by synthesis, it is most probably 3′, 4′, 5 trihydroxy, 7 methoxy flavone, a compound which, so far as is known, has not been previously reported as occurring naturally, although Kostanecki[5] synthesized it by reduction of tetramethoxy luteolin.

Flavones occur widely in plant material, presumably as glycosides, and quercetin, 3′, 4′, 5, 7 tetrahydroxy flavanol, for example, has been reported in white clover. Probably species and growing conditions determine the nature and quantity of the flavone present. Although a quantitative separation of the lucerne flavone could not be effected, there was little doubt that the young third-growth in August contained much less flavone than material grown earlier in the year.

Isolated muscle tests were made on thirty-four flavanoid compounds, most of them kindly supplied by Sir Robert Robinson. These all showed muscle-inhibiting action in concentrations between 1/200,000 and 1/50,000. The influence of various substituent groups in the flavone molecule could not be judged with any reliability, since varying, and generally slight, solubility affected the results.

Our knowledge of the pharmacological actions of the flavones is not extensive. They are reported as diuretics, cardiac stimulants and vaso-constrictors[6], and do not appear to be toxic. Their power to inhibit activity of isolated smooth muscle has been noted by Mahal[7]. They exhibit vitamin P-like activity, and rutin, a quercetin-rhamnoside, is being used therapeutically to decrease capillary fragility. The anti-oxidant action of vitamin P-like compounds towards adrenaline, which results in prolonged adrenaline effects on smooth muscle, have been confirmed with rutin, quercetin and the lucerne flavone, the rutin proving far less active than the flavones.

The significance, if any, of vitamin P in ruminant nutrition awaits elucidation, as also does the possibility of flavones playing some part in bloat. Some preliminary tests have been made on sheep, feeding a flavone with and without potassium cyanide. Nothing of note has been achieved in these tests, apart from some inhibition of rumen movements by the cyanide. One difficulty complicating these tests has been the relative insolubility of the flavone. However, the trials will be repeated in the spring when the animals are grazing and ruminant conditions more closely approach those obtaining when bloat occurs.

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Myosin and Actomyosin Content of the Heart-Muscle

SZENT-GYÖRGYI[1-3] and his collaborators began their investigations on the contractile substances of muscle in 1941; my work on the myosin and actomyosin content of heart-muscle is mainly based on their results.

The extraction of actomyosin was carried out following the slightly modified method described by A. Csapó[4]. Pigs and rabbits were employed as experimental animals. The animal was bled to death, its heart taken out and cooled to − 12° C. The further experiments were performed in the cold room, at 0° C. Two 2-gm. portions of muscle were excised from the frozen right and left ventricle as well as from the auricle respectively; each specimen was ground in a mortar with 6-ml. Edsall's salt solution and sea-sand to a smooth paste. The actomyosin solution was centrifuged, decanted and allowed to stand for 24 hours at 0° C.; then its viscosity was estimated. The measurement was effected in the Ostwald viscosimeter at 0° C., the actomyosin solution having first been diluted with 9 volumes of pH7 veronal–acetate buffer. The viscosity of the actomyosin solution being thus determined, 0·1 ml. of 12 mgm./ml. adenosinetriphosphate solution was added, and then its viscosity measured again. From these two viscosities the myosin content and myosin–actin ratio was calculated, according to Straub and Balenovic. This ratio is expressed as a 'per cent activity' as Straub suggested. The myosin content, and the actin–myosin ratio of 1 ml. of an actomyosin solution extracted as described above, are given in the accompanying table.

	Left ventricle		Right ventricle		Auricle	
No.	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin
1	156	11·5	112	11·0	74	8·5
2	170	9·5	100	11·5	74	8·5
3	179	9·5	120	9·8	110	7·8
4	162	11·0	124	11·0	87	8·5
5	164	11·0	130	10·5	113	8·0
6	180	10·5	122	10·0	97	8·0
7	130	10·0	78	10·0	65	8·0

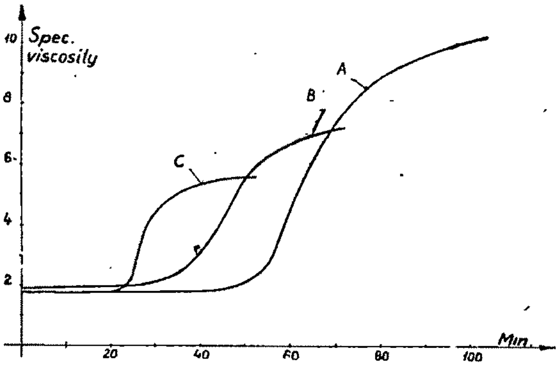
The values obtained, estimated by R. A. Fisher's method[5], give the following results. Average value of the differences between the myosin extracted from the ventricles and auricle respectively: $\bar{x} = 2\cdot3$; t (Student) $= 116\cdot0$; $P \ll 0\cdot001$. Average value of differences between the actin–myosin ratio of the right and left ventricle (expressed as 'per cent activity'): $\bar{x} = 50\cdot7$; $t = 10\cdot5$; $P \ll 0\cdot001$. The average value of differences between the actin–myosin ratio of the right ventricle and the auricle: $\bar{x} = 24\cdot0$; $t = 5\cdot75$; $P \ll 0\cdot001$. Since the P's are much less than 0·05, the lowest limit accepted in medical work, these three differences may be considered as statistically significant.

Experiments carried out on rabbit heart, expressed in the same manner, show the following values:

	Left ventricle		Right ventricle	
No.	% activity	mgm./ml. myosin	% activity	mgm./ml. myosin
1	90	7·0	55	6·8
2	160	9·0	64	8·8
3	120	8·0	56	8·8
4	140	8·0	77	7·8

Proceeding in the same manner as described above, we find that the average value of differences between the actin–myosin ratio of the right and the left ventricle is: $\bar{x} = 64\cdot5$; $t = 5\cdot28$; $P \ll 0\cdot001$. Thus the difference is significant.

My further investigations were extended to a modified Couette (torsion) viscosimeter also. The method was as follows. The actomyosin solution (prepared as described above) obtained from the left ventricle, right ventricle and the auricle of pig's heart was diluted with Edsall solution to about twice its volume, in order to have the same starting concentrations of myosin. The increase of viscosity, caused by the splitting of adenosine triphosphate, was recorded by the Couette viscosimeter, kept by a Hoeppler ultrathermostat constantly at 24° C. exactly. The values thus obtained are given in the accompanying curve. Specific viscosity is plotted against time.



A = left ventricle; B = right ventricle; C = auricle

The results show that there is a difference as regards the contractile proteins between auricle and ventricles, as well as between right ventricle and left ventricle. If we excise the same amount of muscle from the auricle as from the ventricles, we can extract less myosin from the auricle than from the ventricles. The left ventricle, accomplishing most of the work, contains more actin than the right one. The auricles, which do only regulating work, contain less actin than the ventricles.

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Effect of 'Gammexane' on the Durability of Paper

THE use of 'Gammexane' has been recommended for controlling insect pests in libraries and record offices, where insect infestation is a serious problem especially in a tropical climate. 'Gammexane' smoke generators appeared to be particularly suitable for this purpose owing to the ease and safety with which they can be handled. But no information about its effect on paper[1] was available, and the use of a new insecticide for the disinfestation of documents of a unique and irreplaceable nature had therefore to be scrutinized from the preservation point of view.

No. 2 'Gammexane' smoke generators, weighing approximately 2 oz. each, were used at a concentration of 2 oz. per 1,000 cu. ft. as recommended by the manufacturers, Imperial Chemical Industries, Ltd., for insects infesting stored products. Samples of paper were exposed to the smoke for 72 hours in order to allow it to settle down completely, and care was taken to prevent any scorching effect from the smoke generator. Samples exposed to 'Gammexane' smoke were also submitted to accelerated ageing, which consisted in heating the samples for 72 hours at 100° C. The tensile breaking strength and the folding endurance of the treated and control samples were measured according to the standard TAPPI

(Technical Association of the Pulp and Paper Industry, New York) methods.

The mere exposure of paper to 'Gammexane' smoke brought about a substantial decrease in its tensile strength and folding endurance—as much as 53·7 and 71·5 per cent respectively in one instance. Papers exposed to 'Gammexane' and then submitted to accelerated ageing turned slightly yellow, and there was a complete loss of folding endurance in nearly all cases. All-rag hand-made paper of an extremely durable quality used for the repair of old manuscripts had a normal folding endurance of 4,164; but on exposure to 'Gammexane' smoke the retention of folding endurance was 28·5 per cent only, while on accelerated ageing the retention of folding endurance further decreased to zero.

The data obtained conclusively prove that treatment with the No. 2 'Gammexane' smoke generator is definitely injurious to paper records of all kinds and affects their durability as badly as acidic gases[2]. As the water through which the smoke had been bubbled was found to be distinctly acidic, it is almost certain that at least a part of the embrittling effect produced on paper[3] is due to the smoke-generating materials rather than to the 'Gammexane' itself. However, the gases obtained from the smoke generator No. 2 has a deleterious effect on paper, and it is advisable to prevent it coming into direct contact with paper records and manuscripts intended for permanent preservation.

The investigation is being followed up, and the details will be published in a subsequent issue of the *Indian Archives*.

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Zoosporangia, believed to be those of *Plasmodiophora brassicæ*, in the Root Hairs of Non-cruciferous Plants

In 1936, during work on the cytology of *P. brassicæ*, zoosporangia identical with those of this well-known parasite were seen by me in root hairs of grass and dock seedlings, which had appeared in a pot of soil taken from a garden in which the club root disease of the Cruciferæ was a major problem. In view of the known persistence of *P. brassicæ* in soils without cruciferous crops, it was decided to attempt a crude cross-inoculation experiment using club root galls as a starting point. Suitable soil was partially sterilized by keeping it at 190° F. for one hour. Ten six-inch pots were filled with this soil, and club root galls with unbroken surfaces, but of an age known to contain mature spore masses, were cut up and placed in five of them. Brussels sprout seedlings germinated in these pots became infected, and an examination of the root hairs of the grass *Holcus lanatus* grown from seed with them in the re-infected soil revealed numerous zoosporangia and some free-swimming zoospores.

Twenty of these root hairs, which were, so far as could be seen, free from external debris of any kind, were placed in three of the remaining five pots of sterile soil, in which seedlings of brussels sprout were growing. In these three pots, ten of the twelve seedlings became infected, apparently with *P. brassicæ*, while in the two control pots the eight plants remained free from attack.

The root hairs were removed from the *Holcus* plants, after careful washing in distilled water, by sucking the end of the hair into a capillary of suitable size and gently tearing away the required portion. This was done without the aid of a micro-manipulation apparatus, and it is fully realized that it would have been preferable to transfer zoosporangia or zoospores alone. This was, however, not possible. The cycle of events in zoospore formation in root hairs appears to be identical, up to the point at which zoospore formation begins, with the normal cycle in cruciferous roots. The somatic mitoses, transitional phase and reduction division were all seen and were similar to those described for *Spongospora subterranea* by Horne[1] and for *Sorosphæra veronicæ* by Webb[2].

In July 1948 similar zoosporangia were seen by me in two root hairs of 'Auchincruive Climax' strawberry from Botley, Hampshire. Subsequent inquiry revealed that club root had been troublesome in the immediate vicinity.

Plasmodiophora brassicæ has been suspected of infecting plants other than the Cruciferæ on several occasions in the past, notably by Marchand[3] in 1910. The hypertrophy described in these accounts of the disease is now usually ascribed to nematodes, and reports of the presence of the *Plasmodiophora* are treated with great reserve. Marchand[3] saw what he believed to be *Plasmodiophora* in melon, celery and "oseille-epinard", which latter is believed to be a dock, *R. patientia*; but the spore diameter in melon was twice that of *P. brassicæ* in crucifers, and the identity of the parasite is thus open to doubt.

In view of the present methods of control of club root, it is highly desirable that the identity of the zoosporangia I have seen, and the specificity of *P. brassicæ*, should be established by cross-inoculation experiments using all possible precautions to ensure sterility.

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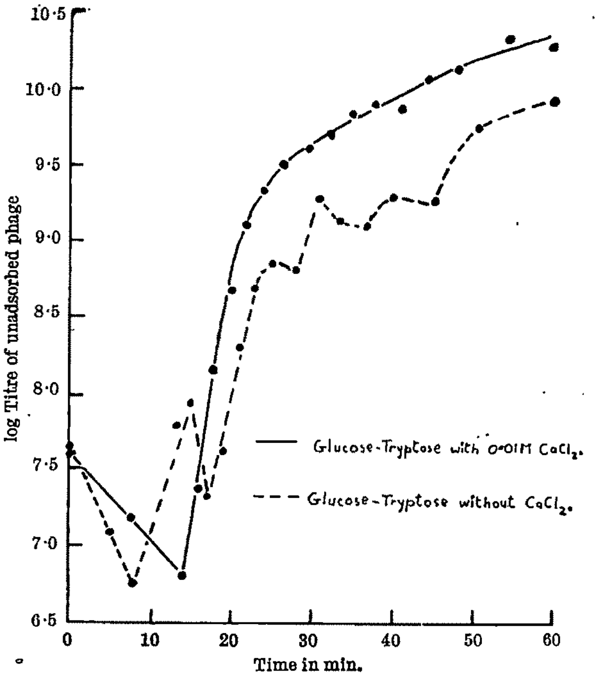
Multiplication of Coliphage at High Concentration

The 'single-step' method devised by Ellis and Delbrück[1] has proved of immense value in the hands of a number of workers in studying the multiplication of various bacteriophages; but it was devised specifically to investigate the behaviour of bacteria and adsorbed phage at high dilution, and gives no direct information about the more complex situation normally occurring, when phage released by lysis of one bacterium can interact further with other bacteria. Since this information was necessary for a line of investigation we are pursuing, and since, moreover, it might prove of more general interest, we have devised the method described below.

Escherichia coli, strain *B*, is grown in a medium consisting of 2 per cent Bacto Tryptose, 0·2 per cent glucose and 0·5 per cent sodium chloride for $2\frac{1}{2}$ hours at 37° C., by which time the viable count is 50–70



million organisms per ml. Coliphage T_2 is then added to produce a final concentration of about fifty million lytic units per ml., and aliquots removed at intervals for assay. These are diluted several hundred times into 0·85 per cent saline containing 0·01 *M* phosphate buffer, *p*H 7·0, maintained in an ice-water bath (slow release of phage from the bacteria occurs at room temperature), and then the diluted mixture centrifuged in an angle centrifuge at 3,500 r.p.m. for 10 min. to remove bacteria and adsorbed phage. An aliquot of the supernatant is further diluted in phosphate-saline and assayed by the plaque-counting method of Hershey, Kalmanson and Bronfenbrenner[2]. From these estimations a curve is obtained giving the titres of unadsorbed phage in the original mixture at various times.

An example of the application of the method is given in the accompanying graph, which illustrates preliminary experiments on the effect of calcium ions on the release of phage from the bacteria. Calcium is known to have a marked effect on the multiplication and plaque formation of phages[3,4,5], but no attempt seems to have been made previously to follow the course of adsorption and lysis in its presence. As the graph shows, 0·01 *M* calcium chloride causes a marked alteration in the form of the curve: in the ordinary medium, multiplication of phage proceeds in a series of stages of adsorption and release, each stage occupying the same time for all bacteria infected simultaneously, so that the graph shows a series of sharp peaks and hollows; in contrast, release of phage and re-infection of further bacteria in the presence of calcium appears to occur in random fashion after the initial adsorption period, the multiplication appearing as a smooth increase in the titre of unadsorbed phage. A number of other points of interest also emerge from these experiments: (1) both in the presence and in the absence of calcium, adsorption of phage on to the bacteria continues logarithmically up to the time when lysis begins; (2) the latent period before lysis commences is lengthened from 8 min. to 14 min. in the presence of calcium; (3) while the experimental curves for adsorption and lysis in the presence of calcium are readily reproducible in other experiments, in its absence only the points of inflexion at 8–9 min., 15–16 min. and 17–19 min. can be reproduced, the later stages being extremely variable; (4) the final titre at 60 min. is invariably higher in the presence of calcium; and (5) the turbidity of the culture is always greater after lysis with calcium in the medium.

The significance of these findings, taken in isolation, is not clear. But the results of other experiments (to be published later) on the effect of enzyme inhibitors on phage multiplication indicate that the calcium ions also probably have an inhibitory effect on one of the enzyme systems of the bacteria.

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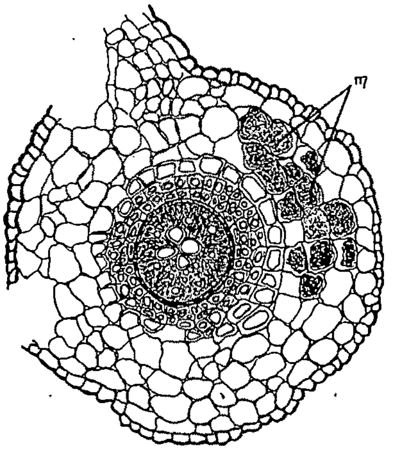
Occurrence of Endotrophic Mycorrhiza in the Roots of *Pteridium aquilinum* Kuhn.

Although Stahl[1] believed that *Pteridium aquilinum* was one of the completely autotrophic ferns, later workers[2-5] have reported the presence of an endotrophic mycorrhiza, and Truszkowska[5] described an endotrophic mycorrhiza in the roots of *Pteridium aquilinum* in Poland which he found growing in soil of *p*H 4·4.

A mycorrhizal condition in roots of bracken in Scotland was demonstrated by Alcock in 1927[2]. Recently, it has been found in two areas in the west of Scotland, where (as Alcock had previously found) it seems to occur irregularly, but possibly more often than was at first realized. The two areas are: (*a*) Drumclog Moor, Milngavie, Dumbartonshire, where roots with mycorrhiza were found in March, April, May and July. The soil was peaty with much humus and had a *p*H of 4·4, a point that agrees with



Transverse section of the root of *Pteridium aquilinum* showing the mycorrhizal layers of cells in the middle cortex. (Camera lucida drawing, × 55)

Truskowska's observations. (*b*) Horticultural land near Auchincruive, Ayr, where roots with mycorrhiza were found in July. The soil was a loam of *p*H 7·7.

Many of the roots of *Pteridium aquilinum* in both these areas were quite unaffected; but those with mycorrhiza were rather fleshy and larger than the others. These features were by no means regular and were not an infallible guide to the presence of the fungus. It has not been seen in the roots of young plants, but such young roots as have been examined were those of cultivated plants.

The accompanying drawing shows the endotrophic mycorrhiza occurring irregularly in the cortical cells of the root. In some cases, the apices of the hyphæ showed small swellings which may be similar to the 'sporangioles' mentioned by McLennan[3]. The fungus was found in the middle cortex, and the thickened cells of the inner cortex showed little infection. It has been seen in several layers of cells and not confined to one cortical layer as described by Rayner for *Aspidium filix-mas*[3]. No special digestive zone could be distinguished.

It is probable that the presence of such an endotrophic mycorrhiza is more widely spread among bracken plants than is at present appreciated.

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Effect of Sulphanilamide and *p*-Aminobenzoic Acid on Mitosis

THE action of sulphanilamide on plant growth shows many parallels to its action on bacterial growth. As Bonner[1], and more recently Audus and Quastel[2], have shown, sulphanilamide will completely abolish growth in length or wet-weight of roots. This inhibition, as in bacteria, is competitively reversed by addition of *p*-aminobenzoic acid to the nutrient solution. Audus and Quastel, however, are of the opinion that the competitive reversal is of a different nature in root growth from that in bacterial growth. Their evidence for this statement is based on the fact that, while in bacteria reversal is complete even with a *p*-aminobenzoic acid concentration 1/50 to 1/4,000 that of sulphanilamide, in roots reversal is complete only when the ratio of sulphanilamide to *p*-aminobenzoic acid is approximately unity.

Plant growth as measured in these experiments is, however, a rather more complex process than bacterial growth, in that the bulk of growth in length or wet-weight is the result of expansion of cells by uptake of water. The amount of 'growth' caused by cell division in the meristems is only a small fraction of the total increase in volume or wet-weight. It seems necessary to attempt a separation of these processes before discussing the mechanism.

The action of sulphanilamide on mitosis in plant cells has been studied by several investigators[3,4,5]. Sulphanilamide appears to have two actions: (1) At concentrations of 0·1–0·5 per cent it stops nuclei coming into prophase, so that there is a fall in number of dividing cells. From experiments on the lateral roots of onion, the number of mitoses is reduced to 0–15 per cent of the original number, after forty-eight hours. (2) In those cells which do begin to divide, the spindle mechanism is upset so that the anaphase movement rarely, if ever, occurs. As Peters[4] has shown, this leads to the formation of tetraploid cells, the arrested cells with scattered metaphase chromosomes without a spindle gradually lapsing back into a resting stage, thus simulating the action of colchicine.

During the last two years, I have been investigating sulphanilamide inhibition, in an attempt to find whether these effects are reversed by application of *p*-aminobenzoic acid. Both effects appear to be reversible. The accompanying table indicates the kind of result obtained in an experiment in which the *p*H of all solutions was about 4·0.

	Prophase	Metaphase	Anaphase Telophase	Total
Control	290	112	113	515
Sulphanilamide	29	9	1	39
Sulphanilamide/ *p*-Aminobenzoic acid	315	58	59	432

Results of different experiments have varied, and the reversal is not as a rule complete. The numbers for anaphase and telophase have always been less than in the controls, although the divisions which do occur seem to be normal.

In preliminary experiments on the effect of *p*H on reversal, it has been found that at *p*H 7·0 reversal is far less complete than at *p*H 4·0. Possibly this is simply due to ionization and permeability effects, and the different results obtained with bacteria and higher plants may be due to such relationships.

I wish to express my thanks to Prof. A. Burges and Prof. H. N. Barber for advice.

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Occurrence of *Acanthocephalus ranæ* Schrank in Great Britain

RECENTLY, Dales[1] and Eales[2] recorded the occurrence of *Acanthocephalus ranæ* Schrank in Great Britain. Three specimens of this species were discovered during routine dissection of *Rana t. temporaria* L. this session, and a further eight specimens in the departmental collection have been examined. Of the latter, seven were taken from *Bufo b. bufo* (L.) and one from *R. t. temporaria*. A summary of the ten specimens is given in the accompanying table.

The numbers of rows of hooks and number of hooks per row were counted after making camera lucida drawings. As the proboscis was not fully extended in all the specimens, it was not always possible to be absolutely certain about the numbers.

In this Department, an average of twenty-four *R. temporaria* were carefully examined each year from 1927 until 1939 for metazoan parasites. During that time only one *A. ranæ* was found. Further, one of us (H. R. H.) examined the gut of several hundred *R. temporaria* of British origin (exact locality unknown) during the years 1922–24. No specimens of

Number of longitudinal rows of hooks	Number of hooks per row	Total length in mm.	Sex	Host	Locality	Remarks
—	–	approx. 5	♀	*Rana t. temporaria*	Norwich, Norfolk	Specimen lost before detailed examination. Collected Dec. 1948
12	6	5	♀ (gravid)	,,	,,	Collected Dec. 1948
14	6	5	♂	,,	,,	Collected Oct. 1948
13	6	4·5	♂	*Bufo b. bufo*	Amersham, Bucks	
14	6	4·5	♂	,,	,,	
14	5	2·5	♂	,,	,,	Toads collected by Lancelot Hogben, Oct. 1921.
14	5	5	♀ (gravid)	,,	,,	
14	5	3	♀ (gravid)	,,	,,	Specimens of *A. ranæ* prepared by H. R. Hewer when a student
14	5	3	♂	,,	,,	
14	5	2·5	♂	,,	,,	
12	5	4	♂	*Rana t. temporaria*	Newdigate, Surrey	Collected Oct. 1930

A. ranæ were found, although many contained numerous other helminth parasites.

All the specimens recorded above are comparatively short. The samples from *R. temporaria* are too small to be significant. Those recorded from *B. bufo* were not the only specimens found on that occasion. Two or three other members of the class each found a similar number of specimens, all of which were of about the same size. It is possible that *A. ranæ* does not reach the same large size in *B. bufo* as it does in *R. temporaria.*

It appears probable that the distribution of *A. ranæ* in Britain is local; but that where it is found it may be abundant. Obviously, Dales is correct in suggesting that its apparent rarity is due to lack of recorded observations.

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H. R. Hewer

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Feb. 11.

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[1] Dales, R. P., *Nature*, 162, 1001 (1948).

[2] Eales, N. B., *Nature*, 163, 166 (1948)

Nomenclature of Polymyxin Antibiotics

Polymyxin is a term introduced by Stansly, Shepherd and White[1] for an antibiotic substance elaborated by *Bacillus polymyxa.*

Brownlee and his colleagues[2,3] independently reported the discovery, from a different strain of *Bacillus polymyxa,* of an antibiotic designated as 'Aerosporin' which appeared to be similar to 'polymyxin' in its antibacterial spectrum, but to exhibit certain different pharmacological properties[3]. Evidence has recently been obtained[4,5] which confirms that 'polymyxin' differs from 'Aerosporin' both pharmacologically[6,7] and chemically[4,5]. Furthermore, it is now known that different strains of *Bacillus polymyxa* are capable of producing a number of related antibacterial substances which differ chemically[4,5] and pharmacologically[6,7] one from the other.

In view of these circumstances, it appeared advisable to unify the nomenclature of this group of antibiotics in order to emphasize the relationship of the members of the group and to avoid the publication of an array of bizarre names which would only confuse it. This end has been achieved by agreement on 'polymyxin' as the generic term for these antibiotics, the individual members being polymyxin A, B, C, D, etc.

At the present time the known polymyxins may be characterized as basic antibacterial polypeptides, the salts of which are water-soluble, having a unique specificity for the Gram-negative bacteria. The known members have, in common, α,γ-diaminobutyric acid, threonine and a branched C_9-fatty acid as molecular constituents[4,10].

Polymyxin A is the name given to 'Aerosporin'[2]; in addition to L-threonine and L-α,γ-diaminobutyric acid, it contains D-leucine[10]. Polymyxin B contains both leucine and phenylalanine as additional constituents, whereas polymyxin C contains only one additional amino-acid, namely, phenylalanine[5]. Polymyxins B, C and E, the product of distinctive strains of *Bacillus polymyxa*, have recently been announced from the Wellcome Research Laboratories[5,8]. Polymyxin D is the main active component of the material described from the American Cyanamid Company[1,4,11] and contains D-leucine and D-serine in addition to the common constituents[4,5]. Polymyxin E contains the same constituents as polymyxin A, but is distinguished from the latter by partition chromatography on paper[8]. The fatty acid of the polymyxins has been described but not fully characterized. It appears to be the same in polymyxins A, B and D[4,10].

Attention is directed to the fact that no implication of priority is to be attached to the sequential assignment of letters. Assignment of letters to further antibiotics in the series should be based solely on published data which characterize the antibiotic as a new member of the polymyxin group.

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[2] Ainsworth, G. C., Brown, A. M., and Brownlee, G., *Nature*, 160, 263 (1947).

[3] Brownlee, G., and Bushby, S. R. M., *Lancet*, (1), 127 (1948).

[4] Bell, P. H., Bone, J. F., English, J. P., Fellows, C. E., Howard, K. S., Rogers, M. M., Shepherd, R. G., Winterbottom, R., Dornbush, A. C., Kushner, S., and SubbaRow, Y., *Annals N.Y. Acad. Sci.* (in the press).

[5] Jones, T. S. G., *Annals N.Y. Acad. Sci.* (in the press).

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[7] Brownlee, G., and Bushby, S. R. M., *Annals N.Y. Acad. Sci.* (in the press).

[8] Jones, T. S. G., *Biochem. J. Proc.* (July 24 1948).

[9] Brownlee, G., Bushby, S. R. M., and Short, E. I., *Annals N.Y. Acad. Sci.* (in the press).

[10] Catch, J. R., Jones, T. S. G., and Wilkinson, S., *Annals N.Y. Acad. Sci.* (in the press).

[11] Shepherd, R. G., Stansly, P. G., Winterbottom, R., English, J. P., Fellows, C. E., Ananenko, N. H., and Guillet, G. L., *J. Amer. Chem. Soc.*, 70, 3771 (1948).

AIR SAFETY

It is a maxim of aircraft design and operation that economics and safety are complementary factors, and that it is always possible to achieve a favourable financial return by ignoring safety considerations, whereas too great a concentration on safety tends to result in economic failure. It is in the achievement of a fine balance of the two factors that the skill and ability of the efficient designer and operator manifest themselves.

This maxim was, no doubt, very much in mind, although never stated, at the all-day discussion on air safety held by the Royal Aeronautical Society on March 5 at the Institution of Civil Engineers. Four papers were presented covering different aspects of the problem, but few significant advances of scientific interest were revealed.

The first paper, by Mr. J. D. North, was on "Some Aspects of the Relationship between Airworthiness and Safety". In this paper, Mr. North brought some of the concepts of philosophy and psychology to bear on the problem. Starting with the conception of 'net yield' (being the difference between 'gross' yield and a somewhat indeterminate quantity 'damage'), he analysed the factors involved in the various terms, the principal ones being the environment, the human factor and the type of aircraft. The method of analogy provided the main approach, and his analogy was that of a game having the nature of patience or solitaire, the object of the game being to move along a grid containing several hazards and to lose the minimum number of points, the optimum path representing the time–space motion which gave the minimum damage. Statistically there is no doubt some basis for such an analogy; but the discussion indicated a certain lack of appreciation of Mr. North's methods and objectives. Apart from criticism of the vagueness of the term 'damage'—which, when interpreted as loss in prestige as well as material loss, may well alter the framing of the initial concept—one of the chief objections to the analogy is that it is unnecessary to import into the science of aeronautics unfamiliar methods and notations which lead eventually to results derivable far more simply by the usual methods. Indeed, there was great doubt as to whether more than a tiny percentage of those present at the discussion understood Mr. North's paper.

The second paper, on "The Physiological Aspects of Air Safety", was read by Dr. K. G. Bergin. The advances in the field of aviation medicine at the present time are naturally associated with the advances of aviation generally. Particular points of interest are the effects of high accelerations and decelerations, high-altitude effects, low-temperature effects, effect of vibrations, and the toxic effects of fumes. All these are, however, problems which arise principally in military aircraft, and so it was a much more restricted field of rather less interest that was covered by Dr. Bergin, who dealt with questions occurring during normal civil operations.

Referring to the question of vision, Dr. Bergin stated that the average percentage decrease in range of night vision varies linearly with altitude, being 5 per cent at 4,000 ft. and 35 per cent at 16,000 ft. Other factors reducing night vision include glare, lack of oxygen, smoking, alcohol, inadequate vitamin A, and fatigue. Suitable precautions can always be taken to ensure that diminution in visual acuity is not dangerous, particularly since the effect is temporary. A more serious problem is the permanent and irreversible deterioration in hearing, known as aviation deafness, resulting from the constant bombardment of the ear by noise over a period of time. The trouble is progressive, starting with a reduction of auditory acuity over the high-frequency range and eventually including the low tones as well. Lack of oxygen is a great potential source of accidents, since it results in false impressions of the pilot's own capabilities, a diminution in skill, speed of reaction and accuracy of attention to detail. The vision is also affected, particularly the power of accurate focusing and optical convergence.

On the question of equilibrium, Dr. Bergin described three common disorders: the autokinetic illusion, the oculo-gyral illusion possibly complicated by autokinesis, and the oculo-gravic illusion. The first of these consists of the apparent movement of an object when viewed against a dark background in the absence of spatial localization. The condition is dangerous only if it occurs at a critical moment. The second illusion is due to conflicting impulses from the eye and the semicircular canals in the part of the ear known as the labyrinth, which, following angular acceleration, results in the apparent movement of objects. The third illusion is due to conflicting impressions between the eye and the otolith organ, and, following accelerations, consists of an apparent displacement of an object in space. The effect of the illusions can be eliminated by blinking, by the use of flashing lights instead of steady lights, or by the use of a number of non-planar lights.

The elimination of fatigue of personnel is important in accident prevention, since fatigue can result in diminished nervous impulses, slowed reactions, impairment of judgment, vision and hearing. Dr. Bergin emphasized the necessity for proper rest for the pilot between flights, adequate diet, and good conditions inside the cockpit. The latter should include proper seating, good windshield design, correct positioning of the instruments and controls, and good insulation. By great care of the health of the crew the risk of accidents can be diminished, and thus the medical aspects of aviation are of fundamental importance.

The third paper, by Capt. J. W. G. James, was entitled "Air Safety from the Pilot's Point of View". His paper was, of necessity, more concerned with the human element than with a scientific approach. He dealt with most of the current difficulties encountered by pilots, in particular stressing the need for better control-cabin layout and good handling characteristics (involving light controls, rapid response, low safety speed, stability, and no change in longitudinal trim during flap and undercarriage movement). The importance of proper training for pilots in order to achieve a high standard of technique, particularly in instrument flying, cannot be overstressed, and Capt. James expressed very definite views on this point. He also advocated the use of a medical service for maintaining health—as distinct from its use as an examining body—which at the moment is the function of the Ministry's medical service. He was somewhat critical of the present conception of 'flying hours' as a criterion for pilots' efforts, and suggested that an 'hours on duty' restriction may eventually be introduced. He felt, however, that all restrictions of this type could be more easily handled by the co-operative effort of the pilots and operators. On the question of operating technique, Capt. James laid down recommended procedures and suggested that the use of drill cards for checking their implementation is desirable. The procedures, although of interest and conducive to increased passenger comfort, would not seem to increase the inherent safety of operation. He deplored the lack of standardization of air traffic control systems—some five are in common use—and expressed the view that such variations tend to decrease safety owing to the excessive practice required to maintain efficiency. The subject of accident investigation—about which much was said in the later discussion—has always been of particular interest to pilots, and Capt. James stressed the importance of this, since only by adequate representation of pilots on investigating committees can the stigma of pilot's error be avoided. (A rather interesting point raised in the course of the discussion was that the term 'pilot's error' might well be replaced by 'designer's error', since the possibility of guarding against possible mistakes in operation can well be regarded as the designer's responsibility.)

The last paper, presented by Dr. G. E. Bell, was entitled "Operational Research into Air Traffic Control". This paper was concerned with experimental investigations (including time and motion studies of take-off and landing, studies of air/ground communications, and an analysis of the traffic and traffic pattern in south-eastern England) and with theoretical investigations into the problem of traffic congestion. The quantitative data on the distribution of delay times was extremely enlightening. In August 1948, at London Airport, about 40 per cent of the incoming aircraft were held for an average time of rather less than 10 min., the average holding-time for all aircraft being some 3½ min. At Northolt, where the loading is heavier, the corresponding figures are 65 per cent held for an average of 16½ min. with an overall average of 10½ min. Approach times vary between 6 and 15 minutes, whereas runways are occupied for between 8 and 9½ minutes for each landing. Thus landing delays are considerable, and the necessary stacking increases the risk of collisions. Dr. Bell presented an analysis of the traffic congestion problem on the assumption of a constant holding-time and based on considerations of statistical equilibrium. He showed that by a knowledge of the 'expectancy' ε, or average number of arrivals in the holding time T, and of the values of the arrival probabilities, the probable degrees of congestion can be estimated. Assuming the Poisson distribution of probabilities, the mean delay is given by

$$t = \frac{1}{2} \frac{\varepsilon}{1 - \varepsilon} T.$$

The effect of deviations from stipulated fixed intervals of arrival was also considered, and it was found that the improvement of a scheduled arrival-rate over a random one is only marked when the standard deviation is small compared to the scheduled interval.

He concluded by pointing out that the capacity of an airport is seriously affected by the 'holding time'; thus at a factor of 0·8, a 10 per cent reduction in holding time increases the capacity and reduces the average delay for the same congestion by some 10 per cent. The most promising approach to reduced holding times is the greater use of radar control.

Much can be said of the value of the day's discussion, but undoubtedly the contribution to the subject of 'air safety' was very limited. Too many gaps were left to regard the meeting as satisfactory. The attitude of the designers and the official regulating body (the Air Registration Board) only slipped in during the general discussion following the papers, instead of being adequately covered by formal statements; and it is a great pity that too much time was spent by the principal speakers on matters outside the scope of the day's proceedings, and too little on the fundamental requirements for an improvement of 'air safety'. HENRY ROBERTS

BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

THE British Hydromechanics Research Association was officially incorporated on September 20, 1947, as a company limited by guarantee, and at the first annual general meeting held a month later Sir John Anderson was appointed president, and a council of ten elected. In the Association's first annual report, which has recently been issued, a review is given of the progress during the period October 1947–September 1948. Mr. L. E. Prosser was appointed director of research in April 1948, and a small staff was recruited later in the year. Thirty-one manufacturers of hydraulic and related machinery are members of the Association, and the associate members include twelve firms of consultants and twenty professors and academic workers. Although directly controlled by industry, the Association operates under the ægis of the Department of Scientific and Industrial Research, and it is hoped that, in the very near future, with adequate support forthcoming from industry, the Association will qualify for a Government grant.

The aim of the Association is to promote original research in hydraulics, and in the application of scientific principles to the manufacture and use of hydraulic machinery and equipment. In this connexion it acts as a liaison between industry and university and Government research laboratories. An efficient information service is being built up to collect and disseminate to the members technical information on hydromechanics and related topics. There is a need for an abstract service covering current publications on hydraulic science, and the *Bulletin* of the Association should prove very valuable in this respect. The first number of the *Bulletin* appeared at the end of 1948, and its contents include a selection of non-critical abstracts arranged in accordance with the universal decimal classification, Association news, and book reviews.

Six sectional research committees, dealing with fundamental fluid mechanics, measurement and laboratory technique, pumps and turbines, control and motion of fluids in pipes and valves, seals and joints, and reciprocating machinery, have been set up. The names of the members of these committees and the subjects under consideration are listed in the annual report. There is little doubt that the Association can become invaluable to the hydraulic industry of Great Britain, and, as Sir John Anderson points out in his foreword to the report, "the formation of this new Research Association is more significant than its present modest development would indicate, as it represents a further step towards a closer relationship between Government and technical interests of industry".

TEMPERATURE MEASUREMENTS IN ECOLOGICAL ENTOMOLOGY

By W. G. WELLINGTON

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MUCH research in ecological entomology is concerned with the effects of temperature upon insects. Nevertheless, there is still some dissatisfaction with instruments or methods employed to measure temperatures for entomological purposes. Difficulties are often encountered in projecting laboratory data to field situations, or in attempting to reverse this procedure, and it is admitted that the numerous special methods for registering air temperature outside standard shelters yield figures which are, for some purposes, no more closely associated with an actual habitat than are shelter temperatures.

It is known that the marked differences observed between the temperature of the air and that of individual parts of both plants[1-3] and insects[4-7] result from radiant heating or cooling as well as from moisture transfers. At least so far as radiant heating is concerned, the temperature differences produced may be so large that, when they occur, continuous records of air temperature are of little value for connecting the results of laboratory and field observations. Thus, it seems time to pay some attention to means of obtaining more useful temperature records.

Such temperature differences as have been demonstrated have been measured chiefly by thermoelectric means. However, indicating potentiometers are limited in usefulness by the fact that they give only instantaneous measurements; and, for general field use, there is a great need for simpler and less expensive recording equipment than power-dependent recording potentiometers.

Both the plant habitats of insects and insects themselves behave more or less like black bodies. This being so, it would seem profitable to investigate the uses of thermometric equipment modified so that it may absorb or emit radiation freely. This approach requires some changes in our attitude towards thermometry. Hitherto, although entomologists rejected the instrument shelter which attempts to standardize radiational errors in temperatures measured for synoptic or climatological purposes, they have assumed the attitude of meteorologists towards the exposure of instruments to radiation. Thermometer bulbs and thermograph bimetals are still shielded or polished 'to minimize undesirable' radiation effects. While there are very sound reasons for this when air temperatures are involved, in situations where plant or insect temperatures may differ by 5–20° C. from ambient temperatures, what is the point of measuring air temperature? It would seem preferable to try to make some of the existing instruments as similar as possible to the natural bodies and to expose them to equivalent conditions. Admittedly, there are some recognized objections to this procedure, which are based on varying heat capacities and on the blunt statements that no measured temperature is what one thinks it is; but the technical difficulties are not insurmountable if thinking is directed along lines differing from the accepted approach. More often than we realize, the chief interest of an ecological entomologist in radiation is in its temperature effects, not in its intensity. Wider recognition of this might diminish the numbers of ingenious adaptations of precision thermopiles and bolometers, from the records of which ecologists laboriously convert the heating or cooling effects of radiation—which are what they need—into units of radiation—which they can seldom apply. Furthermore, to obtain these records, the instruments are carefully shielded from air temperature and movement which act constantly upon the natural 'black bodies'.

Recent tests of a modified thermograph at this Laboratory have shown promise. During tests of the effects of radiant heating upon the foliage of *Abies balsamea* Mill. under field and laboratory conditions, it was noticed that blackened thermocouples or junctions attached to blackened aluminium disks reached the same temperatures as did the interiors of closed or expanded buds, or of enclosed tortricid feeding chambers. On the other hand, these special junctions were better 'black bodies' than the individual needles, but less efficient than staminate flowers. These junctions were matched, and while similar temperatures were recorded at the points noted above, consistent differences were recorded between the flower and vegetative buds and between all foliage and the surrounding air, so that the similarities observed did not result from peculiarities of the junctions. When field observations were extended to other tree species (*Picea glauca* Voss, *P. pungens* Engelm., *Pinus Banksiana* Lamb. and *Populus tremuloides* Michx.), the relationships were found to hold among coniferous species and, while normal aspen leaves were not equivalent to black surfaces, the temperatures of air spaces enclosed by leaves rolled or tied by tortricids were equivalent to those of the surfaces. Finally, the bimetal of a thermograph was blackened and the instrument was exposed beside the trees and the disks. Close agreement was obtained among the temperatures of the buds, shoots, tunnels, disks and bimetal under conditions of uniform exposure. The thermograph pen, of course, often recorded fluctuations amounting to 5° C. in sunlight, but, at such times, the foliage temperatures moved through the lower third of this range very consistently, or, at worst, fell 1° below it momentarily. At the same times, air temperatures ranged up to 6° lower than the foliage. In the absence of fluctuations, foliage and bimetal temperatures were equivalent or within 0·5°, while the air temperature was still too low.

The fact that a black paint ('Drop Black Enamel') chosen at random and applied to a bimetal produced temperatures in far better agreement with bud or enclosed air-space temperatures than were air temperatures, suggests that this approach is worth further investigation by interested workers in a position to test instruments under more varied conditions than are available within the present narrow limits of altitude and latitude. Such tests seem worth while even when it is to be expected that treated bimetals cannot record temperatures similar to those of great numbers of plants or insects since, as noted above, discrepancies appeared in tests of staminate flowers or of individual needles of one species.

During the preliminary tests, at least an indicating potentiometer and thermocouples are essential for establishing the relationships. Any weatherproof thermograph may be used, but the bimetal must be freely exposed. Some workers may prefer models which record at a distance, so that the bulb may be placed in a tree, while the recording mechanism remains accessible. It should be emphasized that large discrepancies will occur during preliminary comparisons between foliage and thermograph if conditions of exposure are not uniform. A surprisingly small amount of shade, which may not be obvious during casual inspection, will produce differences of 2–3°. Also, exposure to winds should be uniform during the tests.

There is no reason why paints with different absorption bands should not be tested. Moreover, in tests related to broad-leaved plants, it might be advisable to wrap a portion of the bimetal in a moist wick to simulate the effects of transpiration. Actually, the leaves of certain field crops appear to be long enough, so that living leaves might be wrapped around a suitably placed bimetal. Other modifications of existing equipment will occur to the reader interested in obtaining more representative temperature measurements.

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STATE SUPPORT IN SWEDEN FOR SCIENTIFIC PUBLICATIONS

By Dr. GÖSTA W. FUNKE
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FOR several years science in all civilized countries has enjoyed considerable Government interest—an interest which has, among other things, found expression in the placing at its disposal of considerable sums of money for apparatus, buildings, salaries, etc. On the other hand, very little seems as yet to have been done to facilitate the publication of the ever-increasing flow of the results of the research which has ensued as a consequence of improved conditions for scientific investigation. It is self-evident that facilities for publication must be expanded to keep pace with the expansion in scientific activity if the latter is to be fully utilized. That this fact is appreciated may be seen from the Royal Society Scientific Information Conference held last summer in London. At this Conference several speakers emphasized the necessity for Government measures to support publication, so as to complete the official steps which had already been taken for the benefit of science. Since Sweden has, by decision of the 1947 Riksdag, voted a grant for the publication of the results of scientific work, which is large in relation to the country's circumstances, a short summary of this measure may be of interest and provide a stimulus towards similar measures in other countries where there are corresponding requirements.

The grant in question is only intended for the publication of the results of basic research in the field of pure science; but it is hoped shortly to obtain a similar grant for technical and medical research, etc. The grant amounts to 300,000 Swedish crowns (rather more than £20,000) per annum, and is administered by the Swedish Natural Science Research Council. For purposes of comparison, it may be stated that the Council has at its disposal for distribution in grants for actual research work the sum of 1,000,000 Swedish crowns (about £65,000) per annum. The proportion between grants for research and publication is thus approximately in the ratio of three to one, which shows the importance attached to the facilities for publishing the results produced by research.

For the administration of the grant the Council has set up a special Publications Committee, with representatives of scientific research workers, editors of periodicals, libraries, and printing specialists. The greater part of the grant is used to assist periodicals; but contributions are also made towards text-books and manuals, monographs, etc. A special item is the contribution towards the printing of doctorate theses, of which the expense had formerly, to a large extent, to be borne by the writers of the theses themselves.

It has been possible to start several new periodicals with the help of this grant, as, for example, *Acta chemica scandinavica*, *Tellus* (a geophysical periodical), *Physiologia plantarum*, *Oikos* (a periodical devoted to ecology), and to expand those already in existence. It is the intention of the Council to support only periodicals of international standing. The new periodicals have therefore generally come into existence with the collaboration of, and financial contributions from, the other Scandinavian countries, Denmark, Finland and Norway. In order to promote their circulation abroad, it is stipulated that articles in those periodicals assisted by the Council shall for the most part be written in English, French or German. The Government grant also enables the Research Council to consider other forms of publication.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, April 19

Society of Chemical Industry, Agriculture Group (in the Chemistry Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. S. J. Watson: "The Chemistry of Ensilage".

Tuesday, April 19—Saturday, April 23

South-Eastern Union of Scientific Societies (at the King's School, Canterbury).—Fifty-third Annual Congress.

Wednesday, April 20

At 8.30 p.m.—Mr. F. H. Edmunds: "Geological Surveys and their Influence" (Presidential Address).

Friday, April 22

At 7.45 p.m. (at the Chapter House).—Young Naturalists' Evening.

Wednesday, April 20

Royal Institute of Chemistry, London and S.E. Counties Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 3 p.m.—Symposium on "Standardisation in the Chemical Field".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. G. E. R. Deacon, F.R.S.: "Waves and Swell" (Symons Memorial Lecture).*

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. J. Gough and Mr. J. E. Wentworth: "The Use of Thin Sections of Entire Organs in Morbid Anatomical Studies"; Mr. E. W. Taylor: "The Phase-Contrast Microscope with particular reference to Vertical Incident Illumination".

Wednesday, April 20—Thursday, April 21

Society for General Microbiology (at the Royal Institution, Albemarle Street, London, W.1).

Wednesday, April 20

At 11 a.m.—Symposium on "The Nature of the Bacterial Surface".

Thursday, April 21

At 10 a.m.—Scientific Papers and Demonstrations.

Thursday, April 21

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Messrs. H. R. Potts and E. G. Lawford: "Recovery of Sulphur from Smelter Gases by the Orkla Process at Rio Tinto".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "Semi-Conductors and Rectifiers" (Fortieth Kelvin Lecture). (To be repeated on Monday, May 2, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.)

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. E. W. R. Steacie: "Gas Phase Reactions of Organic Radicals".* (Further Lectures on April 22 and 25.)

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. George Polya (Stanford University): "The Variation of a Circle".* (Further Lecture on Friday, April 22.)

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Discussion on "Frequency Modulation and Amplitude Modulation" (to be opened by Mr. C. E. G. Bailey and Mr. J. R. Brinkley).

Royal Aeronautical Society (at the Municipal College, Portsmouth), at 7 p.m.—Mr. R. R. Duddy: "High Lift Devices and their Use".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Scientific Study of Paintings" (to be opened by Mr. F. I. G. Rawlins, Dr. H. J. Plenderleith and Mr. S. Rees-Jones).

Friday, April 22

Institution of Chemical Engineers (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Twenty-seventh Annual Corporate Meeting; at 12 noon.—Mr. H. W. Cremer: "Scientific Communication" (Presidential Address).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 25th Duddell Medal, Prize and Certificate to Prof. K. M. G. Siegbahn; Prof. Siegbahn: 25th Duddell Lecture.

Physical Society, Acoustics Group (at the National Hospital, Queen Square, London, W.C.1), at 5.30 p.m.—Messrs. T. Gold and R. J. Pumphrey: "The Theory of Hearing".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. E. G. Bailey (New York): "Invention and the Sifting Out of Engineering Facts" (James Clayton Lecture).

Institute of Metals, Birmingham Local Section (joint meeting with the Local Section of the Royal Institute of Chemistry, at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6.30 p.m.—Dr. W. H. J. Vernon: "Corrosion".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. J. D. Kendall: "The Chemistry of Photographic Sensitizing Dyestuffs".

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Mr. R. J. Callow: "Opal Glasses".

Friday, April 22—Sunday, April 24

Prehistoric Society (at, and in conjunction with, the University of London Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1).—Conference on "Prehistoric Houses and Farms, and some Later Comparisons".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Assistant in Mathematics at the Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (April 23).

Public Analyst and Agricultural Analyst—The Town Clerk, Town Hall, Manchester 2, endorsed 'Public Analyst' (April 23).

Lecturer in charge of the Mining Department at Canterbury Technical College—The Acting Chief Education Officer for Canterbury, 78 London Road, Canterbury (April 23).

Senior Lecturer in the Textile Department, a Lecturer in Biology (to teach two of the following: Zoology and Physiology to degree standard, and Bacteriology to intermediate standard), a Lecturer in Physical Chemistry (to teach up to degree standard), and a Lecturer in Physics (to teach Heat and Properties of Matter to degree standard)—The Acting Clerk to the Governors, Nottingham and District Technical College, Nottingham (April 23).

Director of the Chemical Research Laboratory at Teddington—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2490 (April 29).

Assistant Lecturer in Chemistry, a Lecturer in Pure Mathematics, an Assistant Lecturer in Physics, and Lecturers in Education, with special qualifications in (*a*) Principles of Education with Classics, (*b*) Chemistry and Physics, (*c*) Geography—The Registrar, University College, Hull (April 30).

Physicists, Mechanical or Electrical Engineers (Senior Experimental Officer grade) at the Royal Aircraft Establishment, Farnborough, and other establishments in South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.437/48A (April 30).

Lecturer in Physics at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1 (April 30).

Lecturer in Physics and Mathematics—The Registrar, Merchant Venturers' Technical College, Bristol (April 30).

Research Studentships in Experimental or Theoretical Physics—The Director, Wills Physical Laboratory, The University, Bristol (May 1).

Lecturer (Grade II) in Applied Mathematics—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 6).

Lecturer in Mechanical Engineering—The Registrar, The University, Leeds 2 (May 7).

Lecturer in Geography—The Secretary, The University, Aberdeen (May 14).

Principal Scientific Officers at a Ministry of Supply Research and Development Establishment near London: (*a*) Mechanical or Chemical Engineer (Ref. F.223/49A) for work on the design and development of rockets and associated problems; (*b*) Mechanical or Electrical Engineer (Ref. C.208/49A) for work on artillery equipments and associated engineering problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 14).

Lecturers or Assistant Lecturers (3) in the Department of Physics—The Registrar, The University, Manchester 13 (May 14).

Assistant Lecturer in Bacteriology—The Registrar, The University, Manchester 13 (May 21).

Research Fellowship in Mathematical Physics, and an Assistant Lecturer (Grade III) in Mathematical Physics—The Secretary, The University, Birmingham 3 (May 30).

Johnstone and Florence Stoney Studentship for research in biological, geological, meteorological or radiological science in Australia, South Africa or New Zealand, and a Junior British Scholarship for research or training for research—Research Applications, British Federation of University Women, Ltd., 17a King's Road, London, S.W.3 (May 30).

Lecturer or Assistant Lecturer in Geology—The Secretary, The University, Aberdeen (May 31).

Boots Research Scholarship tenable at the Long Ashton Agricultural and Horticultural Research Station—The Secretary and Registrar, The University, Bristol (May 31).

Lecturers and Senior Lecturers in Physics—The Secretary of the University Court, The University, Glasgow, W.2 (May 31).

Royal Society, Armourer and Brasiers' Company Research Fellowship in Metallurgy—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 1).

Assistant Lecturer in Zoology—The Registrar, The University, Manchester 13 (June 18).

Research Studentships in Science—The Registrar, The University, Manchester 13 (July 1).

Lecturer in Chemistry—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

Postgraduate Studentships (3) for Fisheries Research in the Colonial Empire—The Under Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

University Graduates (with first- or second-class honours in Botany) for bracken investigations—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Science Graduate as Scientific Assistant on the wood utilization side of the Bureau's scientific information service at Princes Risborough—The Director, Commonwealth Forestry Bureau, New Bodleian Building, Oxford.

Examinership in Botany for Intermediate Examinations in the calendar year beginning January 1, 1950—The External Registrar, University of London, Senate House, London, W.C.1.

Tea Research Officer in Nyasaland to take charge of the existing Tea Experimental Station and also of the projected Tea Research Station—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Rubber Technology (knowledge of Plastics Technology essential)—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway Road, London, N.7.

Honours Graduate (with a first-class basic training in Chemistry or Biochemistry, or Chemical Engineering or Agricultural Chemistry) for training as a Fish Processing Expert—The Under Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Engineers and Physicists in the Engineering Research Department, based at Kingswood, Surrey—The Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1.

Head of the Department of Physiology—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

Lecturer (Grade III) in the Department of Zoology—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Catalogues

Gallenkamp Thermostatic Bath. (Publication No. 513.) Pp. 2. Gallenkamp Laboratory Oven, No. 7840. (Publication No. 514.) Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1948.)

Bibliographies and Reference Books. (List 12.) Pp. 28. (New York: Herbert Reichner, 1948.)

Process Progress. Pp. 12. (Bromley: Wray (Optical Works), Ltd., 1948.)

Towers Isomantles. Pp. 8. Price List of Specialised Laboratory Organic Chemicals. (List No. 582.) Pp. 8. (Widnes: J. W. Towers and Co., Ltd., 1948.)

Sciex Bulletin. No. 3 Technical Series. Pp. 20. (London: Scientific Exports (Great Britain), Ltd., 1948.)

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SCIENTIFIC MAN-POWER IN GREAT BRITAIN

THE recent debates on defence and on man-power in the House of Commons have one feature in common. Through the more responsible speeches there ran a thread of anxiety as to the man-power resources of Great Britain; whether that distribution was, in fact, the most appropriate for current and future needs, and whether the most effective use was being made of man-power in the occupations where it is at present deployed. In the defence debate, concern as to the actual targets for man-power was expressed on the Government side of the House, notably in regard to recruiting both for the Army and for the Air Force. Further, the Minister of Defence referred to his intention of expanding the research staffs in the scientific services, which for the last two or three years have been kept below the desired strength because of what were regarded as the more urgent claims of the universities, the teaching profession and industry, in accordance with the priorities recommended in the Barlow Report on scientific man-power.

In the man-power debate, however, the note of anxiety was more apparent on the Opposition side. Sir David Maxwell Fyfe pointed out that the Economic Survey for 1949 suggests that the Government no longer considers a better distribution of man-power to be an urgent necessity. While the personnel of the public services has continued to increase, the higher man-power targets for the basic industries of coal, agriculture and textiles have not been achieved. The Minister of Labour, Mr. Isaacs, claimed in his reply that in the greater part of the field the estimated distribution of man-power has been achieved, and he did not appear to be seriously worried by the admitted failure to attain the targets for the basic industries. He claimed that there is little to be done by way of distribution of man-power, and that the objective must now be increased productivity or higher output.

The importance of that objective cannot be overstressed; but there is far too large a proportion of the nation's man-power and woman-power engaged in what are essentially non-productive occupations for the question of distribution to be dismissed so lightly, quite apart from the repercussions of one section of the field on another. One undercurrent in the defence debate was a marked anxiety as to whether under the National Service Acts we are getting the right type of Army and Air Force; and, though the question was not asked, it was clearly in the minds of members that, despite the inherent justice of national service when fairly applied, it is scarcely compatible with a highly efficient long-service regular or professional army, or even with a territorial army.

The reality of the disruption and disturbance caused by national service cannot be denied. Whatever advantages a period of national service may have for many, for some it has real disadvantages: they become unsettled and are slow to adjust themselves to a civilian life and efficient production. This may in part be a by-product of life in the Services under conditions of peace-time, and may possibly be mitigated as we succeed in eliminating waste in the Services themselves and utilizing civil personnel more effectively for non-combatant duties. On the other hand, it may be inherent in the system, and the consequent inefficiency and waste a part of the price to be paid.

The interruption of university training is another matter, and even if the vast majority of students do their national service before entering the university, some waste of talent is unavoidable. At the present time this is a serious matter for those firms who wish to expand their research and other scientific staff to seize what may be fleeting opportunities so far as export trade is concerned. It was announced last month by the Ministry of Labour and National Service that there will be no allocation to industry of science and engineering students completing their normal courses at universities and technical colleges in 1949. The only students allowed to defer their military service, apart from a small number taking up special posts in agriculture or coal mining, will be those who are allowed to continue at the universities in postgraduate research, for example, and a small number allocated to priority posts in the Scientific Civil Service. The former of these will in any event be required to carry out their military service before they attain the age of twenty-six. Once the principle of national service is adopted, it is clear that on grounds of equity there should be no exceptions; nevertheless, the policy thus announced is *prima facie* reasonable. Certainly, on economic grounds it is undesirable to employ a professionally trained scientific man or engineer in any capacity other than that for which he is professionally qualified, even in the Services; this is in itself a further argument for the completion of military service before admission to the universities. Nevertheless, the application of the policy will be viewed with dismay by firms which are already experiencing acute difficulty in recruiting scientific staff and which do not share the optimism of the Ministry of Labour as to the numbers available of trained scientific workers and technologists.

It is not only industry that is affected. At the annual meeting of the Carnegie Trust for the Universities of Scotland in Edinburgh on February 21, the complaint was made that Government departments, as well as industrial concerns, were outbidding the universities for their staffs, and that in open competition for brains, scholarship and particularly character, the Scottish universities were severely handicapped by lack of means.

This position has not, of course, escaped the notice of the University Grants Committee, and in the House of Commons on March 15 the Chancellor of the Exchequer said that he accepted the view of the University Grants Committee that the increase of salaries which had become necessary in the medical faculties carried with it, as a necessary consequence, a revision of salaries in the other faculties. The provision made for the universities in the Civil Estimates for 1949–50 will allow supplementary grants to be made to adjust such salaries as from October 1, 1949, on the basis of £1,600 for professors (in London, £1,650), up to £1,600 for readers and senior lecturers, £500–1,100 for lecturers and £400–500 for assistant lecturers. This announcement indicates that steps will be taken to rectify a situation which has been regarded with increasing concern by one body after another that has looked at university finance in recent years.

Nevertheless, that is not the most important aspect of the situation. The central fact to be realized is that a satisfactory distribution of scientific and of general man-power and a correct overall policy may be distorted by action taken to rectify an admitted weakness, or even grievance, in one particular field, because of its repercussions in other sectors. Quite recently, reference was made in these columns (see *Nature*, December 25, 1948, p. 977) to the new tensions which the recommendations of the Spens Report threatened to introduce, particularly when the operation of the economic factors which would normally restore the balance was retarded. Further point is given to those comments by the announcement on March 17 of the salaries and conditions of service for specialists in the new health service which, based on the recommendations of the Spens Committee, the Government proposes to adopt. We are here only concerned with the fact that the standard set for specialists is bound to influence the earnings of other medical men and, through them, the earnings of other professions. The importance of the financial motive can be over-estimated; but it is sometimes a decisive factor in the choice of profession and, perhaps more important still, in the choice of occupation within a profession. To use it without much forethought and careful preparation to adjust the distribution of man-power within a profession is a delicate operation and liable to be attended with awkward and undesirable effects elsewhere.

Although it is a tool to be used only as a last resource, the economic motive is one that cannot be ignored. Hitherto, the professional classes generally have exercised considerable restraint in the matter of remuneration during an inflationary period. The Parliamentary and Scientific Committee has therefore done well to appoint a broadly based subcommittee to inquire into the whole subject of payment of scientific and medical teaching staff at the universities, and the general effects on those of similar standing in other spheres. In that unenviable task, they may well find some whose training is far more exacting and starts at a much higher intellectual level than that of the medical graduate but whose financial rewards are far lower; they may well also uncover unfounded claims to higher personal incomes. A report from so representative a committee may be invaluable in restoring some balance and sense of justice.

Economic factors are, however, only one disturbing element; but they well illustrate the way in which Government action itself may have repercussions which affect the distribution of man-power and the balance it desires. More, they remind us that the distribution of man-power is a dynamic and ever-changing element in the nation's affairs. It is rarely static, being affected by internal changing circumstances such as technological developments, and also by external events. Man-power policy can never be finally determined. It must be reviewed continually in the light of the needs of the day, and with the fullest possible informed public discussion, if the Government is to be sure of the public support without which no man-power policy can succeed.

Vital as it is to secure maximum productivity, neither industry nor the nation can afford to accept the view that the distribution of its workers does not require continuous, rigorous and impartial scrutiny. Before embarking on a policy of continued expansion of the Government services, the Minister of Labour should satisfy himself—and also industry and the universities—that there are weighty reasons for it. In view of the general restriction of research activities outside the Government service, due to the present shortage of scientific man-power in Great Britain, the case for increased staffs in Government establishments and the Service departments requires careful consideration.

CHEMISTRY OF THE CAROTENOIDS

Carotinoide

Von Paul Karrer und Ernst Jucker. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 17: Chemische Reihe, Band 3.) Pp. 338. (Basel: Verlag Birkhäuser, 1948.) 43 Swiss francs.

POSSIBLY no better example can be found of astonishingly rapid development of the chemistry of a widely distributed and exceedingly complex group of natural compounds, following upon the introduction of micromethods and specially devised processes, than is afforded by the carotenoids. The first monograph devoted to this topic, "Carotenoids and Related Pigments" (by L. S. Palmer; New York, 1922), contained virtually no detail of structural significance, though this was soon to appear (see, for example, "Carotenoide", by F. Meyer in Meyer–Jacobsen's "Lehrbuch der organischen Chemie", first and second editions, vol. 2, chapter 5; 1929). The adoption of micromethods of oxidation and reduction, the recognition of light absorption of the carotenoids as a valuable characteristic, and, above all, the timely revival of chromatographic analysis, without which the development of carotenoid chemistry might well have been delayed for years, resulted in a surprisingly swift revelation of the main outlines of the chemistry of natural polyenes.

For fifteen years L. Zechmeister's "Die Carotinoide" (Berlin, 1934) has been the sole text dealing exclusively with this detailed carotenoid chemistry. These years, despite the attention of chemists in many countries having been directed elsewhere, have seen much in this field beyond the normal addition to what was known of structural detail. This growth has certainly been notable, for there are now some seventy known naturally occurring carotenoids, the structure of about 50 per cent of which is now fairly precisely elucidated, together with a very large number of stereoisomerides and polyene degradation products. The carotenoids are no longer, however, of interest solely to the academic chemist concerned with the structural patterns of natural molecules. Connexions with vitamin A, visual purple, phototaxis, and even fertilization in micro-organisms, among other topics, afford them outstanding biochemical interest, and it may be said at once that in the volume under review this old and new material has been surveyed and mostly reproduced in all essential detail in masterly fashion.

All that the chemist can reasonably expect in respect of historical data, occurrence, preparative detail, physical and chemical characteristics, derivatives, and original references to individual pigments is set out with exemplary clarity and, it seems, accuracy, in the special section of this book. Readers will be specially grateful to the authors for having withstood the temptation to abbreviate the necessarily cumbersome structural formulæ, as well as their lavish use of tables and the inclusion of representative spectral curves and coloured plates of carotenoid crystals.

General occurrence, determination of structures, physiological significance, and, among other features, distribution of the carotenoids are summarized with scholarly precision, often in tabular form, in a general part; all information such as the organisms producing specific pigments and the pigments produced by specific organisms is made almost instantly accessible, and few facts only (for example, work on vitamin A) seem to have escaped inclusion, obviously because of their recent discovery.

This is in every way a finely produced and very timely work which, so far as can be foreseen, will be the standard text and largely meet the needs of workers in the field of carotenoids for some considerable time ahead.

A. H. Cook

GEOLOGY AND GLACIOLOGY OF THE PLEISTOCENE PERIOD

Glacial Geology and the Pleistocene Epoch

By Prof. Richard Foster Flint. Pp. xviii+589+6 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36s. net.

PROF. R. F. FLINT'S distinguished work in the broad field of glacial geology has been prominent for a generation, and his book is important for that and for other reasons. It deals with the Pleistocene period from the points of view of a geologist and of a glaciologist. Characteristically, perhaps, the author has used stream-terrace data as little as possible, and indeed much of the field work in North America lends itself to the successful pursuit of other methods. Correlation, perennially a difficult subject, is treated so far as possible on geological evidence, not on archæology. The author strives to avoid deduction from any theory of climatic fluctuation which sets up a fixed chronology; he incorporates with his own wide knowledge and experience a considered opinion of an enormous amount of literature, of which a formidable list occupies some forty pages. Significant is the author's introductory statement that "a continuous effort has been made to discriminate between reasoning by induction from field evidence and reasoning by deduction from assumed general conditions"; and there, in a sentence, lies the duty of every scientific worker in the field, laboratory and library.

The book is dedicated to Max Demorest, who lost his life while going to the aid of others in Greenland during the War, and his important contributions to glaciology are incorporated in the author's essential thesis on ice movement. Ten of the twenty-three chapters are given to an objective study, well documented, of glacier ice, its motion and regime, form and distribution, powers of erosion and deposition, periglacial deposits, and glacial stratigraphy. For many, these careful and up-to-date essays will be the *raison d'être* of the book. But sober and engrossing chapters follow on the glacial stratigraphy of North America, Europe and other lands, on changes of level of sea and land, on Pleistocene chronology and climates, on the causes of climatic fluctuation, and the fossil record. Specialists, each in his own field, will be able to supply references and data which will post-date some of those given in the book; some of the subjects are notoriously controversial, but, in the reviewer's opinion, Prof. Flint has dealt faithfully with the past and kept a keen eye to the future of many and varied researches.

The text is well illustrated, with a large number of photographs, some of them excellent, new and intriguing text-figures, tables of correlation and of estimated volumetric data on glaciers, both past and present. Folding plates at the end of the book show the present distribution of land ice, pack ice and storm tracks in southern and northern hemispheres; and stimulating impressions of the same features in the latter hemisphere during the last (Wisconsin) Glacial Age; distribution of loess (in particular) in Europe; glaciated areas in the western United States (with form-lines based on the general altitudes of the floors of the lower cirques); and a sketch-map of the glaciations of Europe. Author and publisher are to be congratulated on the general appearance and presentation of text and illustrative material.

"Glacial Geology and the Pleistocene Epoch" must surely become a standard work of reference; but it is more than that because it is a balanced, objective, creative, and stimulating book, written for an educated public rather than for a few specialists.

K. S. SANDFORD

APPLICATIONS OF GROUP THEORY TO SOME PHYSICAL PROBLEMS

Theory of Groups and its Application to Physical Problems

By S. Bhagavantam and T. Venkatarayudu. Pp. xi+234. (Waltair: Andhra University, 1948.) 20 rupees.

IT is an obvious truism to say that the day is long past when each 'branch' of science was placed in a separate water-tight compartment on its own, divorced from all the other 'branches'. On the contrary, it has become increasingly clear in recent years that these 'branches' are unified in one collective science, and that an advance in one 'branch' will often lead, at a later date, to an advance in some apparently totally different field of investigation.

This is particularly true when the former field is pure mathematics. Thus, the early work on infinite matrices, and the famous book of Courant and Hilbert, "Methoden der Mathematischen Physik", 2 vols. (Berlin: Springer, 1924 and 1937), provided just what was wanted for the development of the Heisenberg–Dirac theory of quantum-mechanics; then linear operators in Hilbert space paved the way for a mathematically sound discussion of Schrödinger's wave equation, and led to proofs, by von Neumann and others, of the spectral resolution theorem for unbounded self-adjoint (hypermaximal) operators. Again, in 1913, by use of the Baire–Osgood theorem that the continuum is not a set of the first category, Plancherel and Rosenthal gave independent proofs of the impossibility of the Maxwell–Boltzmann theory of gases.

Now, in the book under review, the authors provide a lucidly written and well-designed exposition of the application of another abstract branch of pure mathematics, namely, group theory, to some physical problems. The book is exactly what the authors claim it to be, namely, a self-contained and connected account of the above application, intended for those who have no ready access to orthodox treatises already written on the subject. As such, it does not contain novel results, but shows the application of a mathematical tool to existing knowledge. A commendable feature of the book, which is of a mathematical nature, is that physical arguments are not glossed over, and all the results are discussed in detail.

After some introductory chapters on groups and lattices in one and two dimensions, applications of group theory are given to vibrations of a dynamical system, vibrational Raman effect and infra-red absorption, some simple molecules, lattices in three dimensions, vibrations of a crystal lattice, Raman scattering in crystals, rotation groups, problems of atomic spectra, electron spin, some aspects of band spectra, etc. There are also useful appendixes on various matters arising from the text.

In a foreword, Sir C. V. Raman writes of the book: ". . . It represents a serious effort to present a branch of mathematics which is of great and growing importance to physicists generally in a manner which will appeal to and interest them. I believe that the book will be widely read and appreciated." The present reviewer entirely endorses this opinion, and hopes that the book will be read, not only by physicists and applied mathematicians, but also by pure mathematicians who are not too 'pure'.

R. G. COOKE

WOODY PLANTS FOR AUSTRALIAN GARDENS

Shrubs and Trees for Australian Gardens

By Ernest E. Lord. Pp. xxiii+453+125 plates. (Melbourne and Sydney: Lothian Publishing Co., Pty., Ltd., 1948.) £5 5*s*. 0*d*.

THE flora of Australia is one that has always attracted the horticulturist as well as the botanist, both on account of the beauty of many of its species and also because of the high proportion of endemic types. The present work, which is written in non-technical language by a landscape architect and former curator of parks, treats of the trees and shrubs grown in Australia with respect to their horticultural value. To this end the descriptive matter is not such as to serve for the identification of species, but rather for assessing their garden significance and appropriateness for diverse purposes. Sections treat of the trees and shrubs recommended for the various climatic zones in Australia and for special requirements such as for town and roadside planting, those suitable for arid conditions, for the seaside and for small gardens.

The admirable illustrations portray some hundred and fifty species, and of these fifteen are represented in colour. It is scarcely surprising to find that the characteristic Australian family of the Proteaceæ occupies a prominent place among those of especial garden merit. The beautiful crimson *Telopea truncata*, a tree from Tasmania that attains a height of 20–30 ft., is portrayed in its natural colour, but the West Australian *Banksia prionotes* and *Banksia coccinea*, the former a yellow-flowered tree and the latter a crimson-flowered shrub, have a beauty of form to which the black-and-white photographs do full justice. Other noteworthy illustrations from the same family are *Dryandra formosa*, *Hakea laurina*, *Isopogon anemonifolia* and *Stenocarpus sinuatus*. Of the endemic Epacridaceæ, the figure of *Sprengelia incarnata* is especially effective, while the Rutaceæ are illustrated by the charming Correas and Boroneas, which emphasize the relationship of this family with the Ericaceæ. From the Myrtaceæ come the eucalyptuses, the true bottlebrushes (*Callistemon*), and their close relative *Calothamnus*, while mention must be made of the magnificent specimen of *Helichrysum thyrsoideum* and of the interesting blue-flowered Boraginaceous shrub, *Halgania cyanea*.

It is unfortunate that, in endeavouring to compass the trees and shrubs of a continent within the compass of a single volume, so little space could be devoted to each and so little data furnished as to soil conditions. Moreover, despite the desirability of avoiding technicalities in a volume of this character, the absence of any indication as to affinities is to be regretted, since the family to which an unfamiliar subject belongs is often a valuable indication to an experienced gardener as to treatment.

E. J. SALISBURY

CONDUCTION OF ELECTRICITY IN METALS

Leitfähigkeit und Leitungsmechanismus fester Stoffe
Von Prof. Eduard Justi. Pp. xii+348. (Göttingen: Vandenhoek und Ruprecht, 1948.) 15 DM.

THIS book originates from a lecture course which the author, himself an experimental physicist, gave during the War to an audience consisting largely of electrical engineers, with the aim of bridging the gap between the outlook of engineers and physicists. The book covers a field somewhat wider than the original lectures and is written partly in collaboration with experts on special subjects.

The specialization of science has been widely commented upon, and its dangers for the future of science and human thought in general are recognized. Since this book is published with the purpose of counteracting some of the detrimental effects of specialization and establishing stimulating contacts between the worlds of science and industry, it should be welcomed.

Conduction in metals is a phenomenon on which the routine work of electrical engineers is founded, and the author conveys the views of modern physics on the subject to a public to whom presumably even the older physics is not too familiar. This is done by discussing conductivity in terms of moving electrons and reviewing all other phenomena through which the dynamics of electrons in crystals is accessible to observation, such as the Hall effect, thermo-electricity, superconductivity, rectification in surface layers, semiconductors, photoconductivity, ionic conductivity of crystals and similar subjects.

The book is written as a review rather than as a treatise. It consists of accounts on the experimental work in various fields. The author lets the experimental facts speak for themselves and refrains from stressing opinions of his own. Theories are not presented in full, but theoretical results are freely quoted when this is necessary in discussing experiments. There is, however, an elementary introduction to the wave mechanics of electrons in metals.

An apparatus is described by means of which the interference of electrons was demonstrated in the lecture theatre in such a way as to impress the wave nature of matter on the largely non-academic audience. The author is anxious to point out the possible practical applications of phenomena that are, so far, of academic interest only, and he reports, therefore, in detail on the experimental work on the utilization of the free energy of fuel in galvanic cells.

The ample lists of references are obviously supposed to cover everything of importance, including recent work. Heisenberg's papers on superconductivity are quoted; but there is no reference to the recent electron theory of electric breakdown[1].

The book will be useful, in the first instance, to those readers who are interested in the facts rather than in their interpretation. It provides plenty of information for the non-expert, academic or industrial, and may be appreciated even by experts for reference purposes.

R. EISENSCHITZ

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[1] Cf. Fröhlich, H., *Nature*, 158, 332 (1946).

FOOD CROPS

Brassica Crops and Allied Cruciferous Crops
By Chas. H. Oldham. (Agricultural and Horticultural Series.) Pp. 296+20 plates. (London: Crosby Lockwood and Son, Ltd., 1948.) 21*s*. net.

Grain Crops
By Harold K. Wilson. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. xi+384. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 24*s*.

THE production of food continues to be of vital importance to mankind, and there is no dearth of books for the guidance of cultivators. In the two books under review there is a wealth of information on the growing of bigger and better crops.

In "Brassica Crops and Allied Cruciferous Crops" the author has collected together from various, and often inaccessible, sources accurate information about modern methods of growing and marketing vegetables, and has incorporated the results of his own wide experience and observations. He has also given useful descriptions of the varieties generally grown. All this is arranged in thirteen chapters, one chapter for each vegetable, and each chapter is of precisely the same pattern, comprising sections on botanical and historical features, the principal types and varieties, geographical areas of production, maintenance of pure stocks and production of seed, cultivations, marketing, diseases and pests. The alphabetical arrangement of the chapters is confusing, as it involves, for example, the separation of the savoy from the cabbage by no less than six chapters, although both vegetables have many features in common. A more natural sequence would have been obtained by discussing the vegetables of the *Brassica* genus in consecutive chapters.

The book is well illustrated by drawings and photographs, and there is an excellent index. The botanical information is not always accurate, one obvious inaccuracy appearing in Fig. 1, in which the siliqua of the wild cabbage is depicted dehiscing from the apex towards the base. Such details, however, do not detract from the value of the book to the practical man, and commercial growers and private gardeners alike will find this volume invaluable.

"Grain Crops" is an expansion of outlines of a course of lectures on the various phases of the production of grain crops, given to students in the College of Agriculture, University of Minnesota. The subject-matter is arranged in twenty-three chapters, of which the first eight are concerned with a very brief review of the fundamentals of botany, plant classification, the world distribution of grain crops, and a general discussion of their culture. This section is followed by a more detailed discussion of individual grain crops, and these include not only the members of the grass family but also such crops as flax, buckwheat and soybeans. The book concludes with a chapter on the improvement of grain crops.

Each chapter is followed by a list of review questions and a bibliography; but one seeks in vain for a reference to any literature other than American. With the exception of the mention in a footnote of "The Wheat Plant" by John Percival, all literature published outside the United States is ignored. The whole subject is treated purely from the American point of view, since crop rotation, methods of culture, lists of varieties, storage and uses of the various crops all refer solely to American conditions.

While this book is undoubtedly very useful for the American agricultural student and the American farmer, it is of very limited value to agricultural students in Great Britain or, indeed, in many countries outside the United States. The omission of references to work on grain crops by men of science in other countries emphasizes this statement, and surely the "more advanced students", mentioned by the author in his preface, would profit enormously if the "liberal use of selected references" was more truly liberal and indeed international. A. G. ERITH

CRYSTAL STRUCTURES OF INORGANIC COMPOUNDS

Crystal Structures

By Ralph W. G. Wyckoff. Section 1. Pp. viii + 442. (New York and London: Interscience Publishers, Inc., 1948.) 48*s*.

IN 1931 Dr. R. W. G. Wyckoff's "Structure of Crystals" was published and was followed by a supplement in the year 1934; these volumes contained the results of crystal-structure determinations up to about 1933, and many X-ray crystallographers will have found them of utmost value, both as sources of information about structures and as sources of references.

The present work will therefore be greeted by many as an old friend, and they will not be disappointed in its contents. The sections on crystal-structure determination have disappeared, while the discussions of structures and the relationships between them have been extended in the light of recent theories. The details of the structures are repeated from the earlier volumes, together with the well-known diagrams, but the references begin at the year 1933, where the first supplement finished.

There are, however, many changes. The book is published in loose-leaf form, and is printed in imitation typescript; only about half of the book is yet produced, and the rest is to be published in two sections. The author has adopted this method of procedure in order that the main part of the book could be published within a reasonable time; corrections may be made later by the substitution of pages, and new material can be added in appropriate places. The part so far produced is on inorganic structures, arranged in order of complexity of chemical formulæ—elements, compounds *AB*, compounds AB_2, etc.—and the two further sections promised are to cover the inorganic compounds that remain and organic compounds.

One cannot but agree that this method of publication has its advantages for this sort of work, and one must bear with the disadvantages that are inevitable in loose-leaf publications. The pages tend, of course, to misalignment, although they are well clamped together by a simple device. Some instruction on the method of release of the covers would be valuable; X-ray crystallographers may be used to trial-and-error methods; but they do not wish to try them on their books.

The text is, on the whole, well written, although there are some phrases that ring strangely to the British ear: "non-rare gas shell atoms" is an awkward construction that cannot be improved by any ordinary method of hyphenating, and "fifth-column elements" has not the happiest of connotations. The author has also a tendency to use too few commas, as the following extract shows: "If as was done in Chapter II when discussing cobalt and the two forms of graphite layers in these three positions are designated as 0, 1 and 2, then . . ."; a comma after graphite is definitely required.

A technical difficulty, with which the author has unfortunately made no attempt to cope, is that due to the recent change in unit of measurement. Measurements are all given as in Angstrom units; but they are actually in kX. units. If it was not possible to correct all the dimensions given, a covering note explaining the difficulty should have been given; one hopes that such a note will appear in the further sections. But there is no doubt that difficulties will begin to appear when present structures, quoted in true Angstrom units, are included.

The book will inevitably be compared with the "Strukturbericht". Both works cover the same ground in much the same fashion, and it is in this respect that the author claims that the loose-leaf form of publication should have a decided advantage; it will enable all the data for a given material to be kept together, whereas with the "Strukturbericht" one has to look through all the volumes. It will be interesting to see how the experiment works in practice. Certainly all X-ray crystallographers will wish it well and will be grateful to Dr. Wyckoff for the large amount of time and effort that he has obviously spent in compiling the work. H. LIPSON

Chemical Architecture

Edited by R. E. Burk and Oliver Grummitt. (Frontiers in Chemistry, Vol. 5.) Pp. x+202. (New York and London: Interscience Publishers, Inc., 1948.) 4.50 dollars; 27*s*.

THE Western Reserve University in Cleveland, Ohio, has established a reputation for series of lectures in what is usefully termed the "Frontiers of Chemistry". These lectures deal with a variety of topics of current interest. In an expanded and therefore more acceptable form they have been published at intervals during the past few years. This is the fifth volume of the series. The need for reviews of this kind is perhaps more pressing than in normal times because few chemists have had the opportunity of writing monographs on those branches of chemistry in an active state of development.

Under the all-embracing title of this book many topics are discussed by a number of eminent chemists of the United States. In every case the lecture has been much expanded and fully documented, so that each article is an up-to-date and complete summary of the particular line of investigation. Dr. H. S. Taylor leads off with a generally discursive article on the influence of molecular geometry in reaction mechanism, particular attention being paid to heterogeneous reactions where molecular geometry is often of overriding importance. Dr. C. P. Smyth appropriately discusses the more recent contributions that dipole measurements have brought to the elucidation of the structure of a number of molecules in which the method is of particular value. There is a more than usually complete survey of the structure of co-ordination compounds by Dr. W. C. Fernelius. To go to the other extreme of difficulty, Dr. B. E. Warren deals with the important contribution X-ray diffraction studies have made to measuring the degree of disorder and of short-range order in substances like carbon black and certain alloys; and Dr. M. W. Tamele deals with the difficult problem of the structure of gels used as a substratum for the production of catalysts. The longest article, on "Light Scattering in Polymer Solutions", by Dr. H. Mark, is particularly opportune. There has been much talk and a great deal of experimenting with light scattering but not nearly enough published matter, theoretical or experimental. This article will be especially useful to all those interested in this important method.

H. W. Melville

Pohledy do nebe

Problémy a výsledky moderní astronomie. Napsal Dr. Hubert Slouka. Pp. 460+43 plates. (Praha: Nakladatelství Orbis, 1947.) 165 Kčs. *In Czech.* (Exploring the Skies: problems and results of modern astronomy. By Dr. Hubert Slouka. Prague: Orbis, 1947.)

THIS recent astronomy book by the Czech astronomer, Dr. H. Slouka, aims at introducing a wide public to some of the most interesting astronomical problems of to-day. It is not intended as a text-book but rather to stimulate a more specialized study of its large variety of subjects. It falls into eight main chapters: the road to the stars; telescopes of to-day and to-morrow; the sun; the world of the planets; celestial wanderers; the world of the stars and nebulæ; beyond the Milky Way; and the birth and death of worlds. Tables of astronomical data are added as well as a useful bibliographical list. Many of the illustrations are drawings new to books of this kind; in addition, some forty plates are well chosen and beautifully reproduced. The first two editions of the book were published in Prague in 1942, and the author's remarks bear witness to the difficulties of the time in which he worked at it. The book is very vividly written in a manner which the author hopes will help "to win for astronomy new and enthusiastic friends who will strive for this most attractive of all sciences to penetrate to all sections of the public". A. B.

An Introduction to Mathematics

By Dr. A. N. Whitehead. (Home University Library of Modern Knowledge, No. 18.) Twelfth impression. Pp. v+192. (London: Oxford University Press, 1948). 5*s*. net.

THAT the late Prof. A. N. Whitehead's little volume should establish itself as a classic is not surprising. It was published in the "Home University Library" in 1911, was reprinted about eight times, and finally was reset in its present form in 1948 under the supervision of Prof. J. H. C. Whitehead, of Oxford, the late author's nephew. The diagrams have been re-drawn; but apart from the correction of inaccuracies and typographical errors, the author's original wording has, in no instance, been altered. In the reset edition the number of pages has been reduced from 256 to 191; but the text is still quite clear and readable. In seeking to explain the nature of mathematics, it still affords a very interesting account of how mathematics forms the background of all science.

Asparagus

By Alfred W. Kidner. Pp. 168+17 plates. (London: Faber and Faber, Ltd., 1947.) 15*s*. net.

THAT delectable vegetable, asparagus, has been cultivated by man for more than two thousand years; the elder Cato speaks of its cultivation, and it may be presumed that it was known and grown long before that time. Yet in all this long time it has changed little in its character, and, as the author of this book points out, no really fixed and distinct forms or varieties have been produced. It is strange that so esteemed a luxury should never have received much attention from plant-breeders. Largely through chance, Mr. A. W. Kidner took up the problem of selection and breeding of giant forms of asparagus, and through long years of empirical observation, isolation and cross-fertilization developed strains of superlative quality. There is no doubt of the success that has attended his efforts, and they show what might still be done if the genetics of the plant were really worked out and strains homozygous for the desirable qualities fixed.

The author lays no claim to being a man of science, and throughout the work there runs a curious implication almost of surprise that asparagus should respond to controlled breeding methods—a suggestion of pleading a case that special laws operate in this one instance and that it may be difficult to convince the reader of the value of breeding. In this respect, the book is needlessly repetitive; but, as an otherwise straightforward account of how the practical man can go about developing his own super-quality strains and how to grow and market them, the book is of great value. It should certainly stimulate the new National Vegetable Research Station, when it begins operations, to take up the study of the genetics of asparagus. R. H. Stoughton

SOME RECENT ADVANCES IN RADIOCHEMISTRY*

By Prof. H. J. EMELÉUS, F.R.S.

IN the decade since the discovery of atomic fission by Hahn and Strassmann, the subject of radiochemistry has undergone rapid development. It has always been in the background of all the major advances in radioactivity, and the very magnitude of these advances in recent years has resulted in the presentation to the chemist of a wide range of new problems. Three of these will be discussed briefly here. The first, the chemical separation of the fission products of uranium and other fissile elements, is largely a matter of chemical analysis and differs from more familiar analytical problems only in complexity and in the fact that microchemical techniques are used. The second problem, that of fitting the many new radioactive isotopes of the heavy elements into modifications of the classical decay series, has been solved by a combination of the physical and the chemical methods of approach. The third major problem is the study of the chemistry of the new transuranic elements neptunium, plutonium, americium and curium, as well as of those of atomic numbers 87 (francium), 85 (astatine), 61 (illinium or prometheum) and 43 (masurium or technetium), which probably have not been isolated from natural sources but are now available, in small amounts, in the form of radioactive isotopes formed by suitable nuclear transformations.

Fission Products

The isotopes which are known to undergo fission with slow neutrons are uranium-233, uranium-235 and plutonium-239; others (thorium-232, ionium-230, protoactinium-231, uranium-238 and neptunium-237) require fast neutrons, and less information is available on the fission products†. In the fission of uranium-235 by slow neutrons, to take an example, two lighter nuclei are formed in each fission. The following is a typical equation:

$$U_{92}^{235} + n_0^1 = Kr_{36}^{92} + Ba_{56}^{141} + 3n_0^1 + 175\ \text{Mev.}$$

The nuclei formed fall into two groups, a light and a heavy, the most abundant members of which are in the ranges $Z = 35$ to 43 (bromine to technetium) and $Z = 51$ to 58 (antimony to cerium), other less abundant nuclei falling between and outside these two ranges. The fission products have masses greater than those of the heaviest natural stable isotopes of the elements in question. In the case of the krypton and barium isotopes mentioned above, for example, the heaviest stable isotopes have masses of 86 and 138 respectively, and the fission fragments are β-active, which reduces the mass to charge ratio of the nucleus to a stable value. This gives rise to fission decay chains of which the accompanying are typical.

$$Kr_{36}^{92} \xrightarrow[\beta]{3s.} Rb_{37}^{92} \xrightarrow[\beta]{\text{short}} Sr_{38}^{92} \xrightarrow[\beta]{2\cdot7h.} Y_{39}^{92} \xrightarrow[\beta]{3\cdot5h.} Sr_{40}^{92}\ \text{(stable)};$$

$$Xe_{54}^{141} \xrightarrow[\beta]{3s.} Cs_{55}^{141} \xrightarrow[\beta]{\text{short}} Ba_{56}^{141} \xrightarrow[\beta]{18min.} La_{57}^{141} \xrightarrow[\beta]{3\cdot7h.} Ce_{58}^{141} \xrightarrow[\beta]{28d.} Pr_{59}^{141}\ \text{(stable)}.$$

In such chains it is possible for an intermediate member to be formed directly by fission, but in general the chance of this happening becomes less as the stable end is approached. The mass number in the chain is constant, and determinations of fission yield are generally made with reference to this mass number rather than to any particular element. The fission yield is defined as the percentage of all fissions for a given range of neutron energy yielding nuclei of a particular mass number, and its determination calls for methods of analysing the fission products chemically and also for a correlation between the number of fissions and the amount of each mass formed.

In the chemical analysis of fission products, carriers and so-called hold-back carriers are used. The need for a carrier arises from the exceedingly small absolute weights of radioactive material present in the mixture. In separating a particular element, a small amount (1–10 mgm.) of inactive isotopic material is added, which renders manipulation on the micro scale possible. Inactive hold-back carriers are used in similar amounts to minimize radioactive contamination of the element sought by other fission products, which would otherwise be carried down in precipitation reactions. The hold-back carriers do not eliminate this contamination, but they ensure that when it occurs it involves largely the inactive atoms of the hold-back carriers and not the isotopic fission products.

Material for the chemical separation of fission products is now obtained readily by the irradiation of uranium or one of its compounds in the atomic pile. In the early work on fission other neutron sources, such as a radium–beryllium mixture, were used. The following are typical of the many methods of chemical separation employed, carriers and hold-back carriers being used in most cases.

(1) Separation of barium and strontium as nitrates by precipitation with fuming nitric acid, followed by precipitation of barium as chromate and strontium as sulphate.

(2) Direct removal of the rare gases krypton and xenon, followed by the mass spectrographic determination of the various isotopes.

(3) Precipitation of sulphides of arsenic, germanium, selenium, tellurium, molybdenum, antimony, technetium, rhodium and palladium with hydrogen sulphide in acid solution, followed by further separation of the individual elements.

(4) Separation of the rare earths by ion exchange resins.

Following the separation of each element, it is essential to study, and if necessary analyse, the decay characteristics of the product, which may contain several isotopes. Further chemical separation of a daughter element formed in the decay of that isolated is also carried out in many cases, in addition to which the activities observed are identified when possible with those due to isotopes formed in unambiguous nuclear reactions brought about, for example, with the aid of the cyclotron. The information so gained has been fitted together gradually to give a fairly complete picture of all the fission products and their decay chains.

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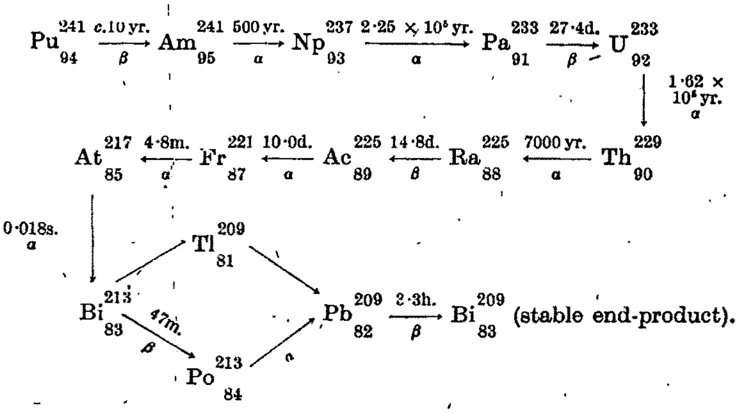
* Based on a course of three lectures delivered at the Royal Institution on March 15, 22 and 29.

† The information contained in this article is drawn largely from declassified reports issued by the United States Atomic Energy Commission, the Division of Atomic Energy of the National Research Council and the Division of Atomic Energy of the Ministry of Supply.



In the atomic pile, the amount of each fission product grows to a constant value at which its rate of formation equals its rate of decay. This makes possible the direct comparison of the relative yields of various fission products from observations made on the activity of materials from the chemical separation, provided the observed activities are corrected for decay during the chemical separation, and also for the fact that irradiation in the pile may not have been long enough for the activity to grow to its saturation value. Other corrections for factors inherent in the counting of β-particles of different energies may also be necessary. To transform these relative values to absolute values, it is necessary to determine absolutely the fission yield of some one isotope. The 12·8-day isotope barium-140 has been much used as a standard, because of its convenient life and ease of separation. If Y_R and Y_S are the yields of two fission products R and S, and $\overset{\infty}{D_R}$ and $\overset{\infty}{D_S}$ the respective saturation disintegration-rates, then $Y_R/Y_S = \overset{\infty}{D_R}/\overset{\infty}{D_S}$.

In determining the absolute fission yield of the standard substance, the essential experiment is to mount a very small weighed sample of a uranium compound in a fission-counting chamber in the thermal column of the atomic pile, and to place in the same neutron flux a larger known sample (for example, 0·1 gm.) of the uranium compound for subsequent chemical analysis. A known weight of carrier is used in the analysis, and the actual weight of this carrier recovered is measured. It carries with it a proportionate amount of the total activity of the standard fission product. Fission-yield curves obtained by the procedure outlined have now been published for uranium-233, uranium-235 and plutonium-239, and they show a great similarity, apart from small displacements in mass due to the different masses of the fissile nuclei.

The New Radioactive Decay Series

The second major radiochemical problem, the place of the transuranic elements in the decay series, has had as its most striking result the discovery of a new series, the neptunium or ($4n + 1$) series, the longest lived member of which is the isotope Np^{237}_{93}. There are, in addition, a number of new branches and extensions of the classical series into which isotopes of elements 93, 94, 95 and 96 have been fitted. The decay scheme of the neptunium series, none of the members of which are known to occur in Nature, is shown above.

The study of the greater part of this series, isolated members of which have been known for some time, has followed from the isolation of uranium-233 in moderate amounts from thorium irradiated in the atomic pile, where it undergoes an (n, γ) reaction followed by two successive β-decays. The radium isotope is separated chemically from the uranium-233 solution, using a barium carrier, and is then found to grow an activity due to an actinium isotope, which is separated with a lanthanum fluoride carrier. This established the β-activity of the radium isotope. The actinium isotope shows four α-activities, the energies of which are studied with the pulse analyser. Of these one, due to the alkali metal francium, may be separated chemically with cæsium perchlorate. The isotope bismuth-213 is separated with a bismuth carrier, and the isotope lead-209 is identified, when it has grown in the actinium solution, by using a lead carrier. This particular activity has been produced by several independent nuclear reactions and the isotopic assignment is clear. There is little direct chemical evidence for the isotopes astatine-217, polonium-213 and thallium-209, and in these cases identification depends largely on physical methods.

The above gives only a general indication of the chemical approach to a problem of this type. Other similar series of radioactive isotopes have been produced by the use of the cyclotron, particularly at the University of California, where so many of these new developments have originated. As an example of the production of a series of synthetic isotopes which form a branch to one of the main decay series, work on the protoactinium series may be mentioned. The parent isotope, protoactinium-230, is formed in the deuteron or helium ion bombardment of thorium and decays according to the following scheme, the last member shown, radium C′-214, being a member of the classical uranium–radium series.

$$Pa^{230}_{91} \xrightarrow[\beta]{17d.} U^{230}_{92} \xrightarrow[\alpha]{20\cdot8d.} Th^{226}_{90} \xrightarrow[\alpha]{30\cdot9m.} Ra^{222}_{88} \xrightarrow[\alpha]{38s.} Em^{218}_{86} \xrightarrow[\alpha]{0\cdot019s.} RaC'^{214} .$$

The Actinides

Chemically, the new elements neptunium, plutonium, americium and curium are believed to form part of a new series, known as the actinides, analogous in the arrangement of their extra-nuclear electrons to the rare earths (the lanthanides). Starting probably with thorium, successive elements gain an electron in the $5f$-shell, which in the case of curium contains seven electrons and is half full (just as the $4f$-shell is half full in gadolinium). The physical evidence for this hypothesis is far from complete: some indication is given by optical and X-ray spectra and by magnetic measurements, while some of the actinide ions in solution have sharp absorption bands, which would be expected if transitions occurred in a shielded inner shell. X-ray studies of a number of compounds of the actinides have also been made and show a contraction in ion size as the series is ascended, which is similar to the lanthanide contraction for the rare earth ions. This is seen in Table 1, where the lanthanide contraction is also illustrated.

Table 1. Crystal radii of actinide and lanthanide ions

No. of *f*-electrons	Crystal radii of ions (A.)					
	Thoride series		Actinide series		Lanthanide series	
0	Th^{4+}	0·95	Ac^{3+}	1·11	La^{3+}	1·04
1	Pa^{4+}	(0·91)	(Th^{3+}	1·08)	Ce^{3+}	1·02
2	U^{4+}	0·89	(Pa^{3+}	1·06)	Pr^{3+}	1·00
3	Np^{4+}	0·88	U^{3+}	1·04	Nd^{3+}	0·99
4	Pu^{4+}	0·86	Np^{3+}	1·02		
5	Am^{4+}	0·85	Pu^{3+}	1·01	Sm^{3+}	0·97
6			Am^{3+}	1·00	Eu^{3+}	0·97

The valencies of the actinide elements are shown in Table 2, together with those of the corresponding rare earths.

Table 2. Valencies of the actinides and lanthanides

Element	Valencies	Element	Valencies
Ac	3	La	3
Th	4, (3), (2)	Ce	4, 3
Pa	5, 4	Pr	5, 4, 3
U	6, 5, 4, 3	Nd	(4), 3
Np	6, 5, 4, 3	Tc	3
Pu	6, 5, 4, 3	Sm	3, 2
Am	4 or 5, 3, 2	Eu	3, 2
Cm	3	Gd	3

Values are in some cases higher than for the rare earths, which reflects the looser binding of the 5*f*-electrons and their more ready promotion to the valency shell. Between uranium and curium there is an increase in stability of the lower valency states, and it is remarkable that americium can be reduced by sodium amalgam to the bivalent state, which resembles the corresponding states of samarium and europium. Both americium and curium resemble the rare earths rather closely, and are best separated from them by the use of ion exchange resins. Numerous compounds of the new actinide elements, and of plutonium in particular, have now been described, and, although their radioactivity and the resulting need for special facilities may render them inaccessible to most laboratories, the chemistry of these substances will undoubtedly shortly be as well known as that of most other elements.

Much less has been published as yet on the chemistry of francium, astatine, prometheum and technetium, the other four new elements mentioned earlier. Astatine in the form of the isotope At^{211}_{85}, an α-active substance of 7·5-hr. half-life, has, however, been used in tracer studies which have given a general picture of its chemistry. The element itself may be extracted from solution with organic solvents and thus resembles iodine. There is also definite evidence from ion migration experiments that it can form negative ions, which are probably analogous to the iodide and iodate ions. The intense α-activity of astatine will, however, render the study of its chemistry on anything approaching a macro scale a matter of very great difficulty. The missing rare-earth element of atomic number 61 has now been clearly identified by its X-ray emission spectrum. It is formed in fission and also in cyclotron reactions, and has been separated with the aid of ion exchange resins. There is, however, no reason to expect that the chemistry of the element will differ substantially from that of the other rare earths. In the case of technetium, at least milligram quantities of one of the long-lived radioactive isotopes have already been prepared, and, in view of its position between manganese and rhenium in the periodic table, the element and its compounds are likely to be of very great interest to the chemist.

BIOCHEMICAL ASPECTS OF GENETICS

It was often emphasized by the late Sir Frederick Gowland Hopkins that a study of the individual cell and of the organisation of chemical reactions within the cell was the true objective of biochemistry. The relationship of genetic constitution to chemical activity is, in such a connexion, a matter of first importance; but it was not until some ten years ago that investigations of this nature could be applied experimentally to unicellular organisms. Following a proper advance in technique, derived largely from the work of Beadle and Tatum, corresponding advances have taken place in the elucidation of genetico-biochemical problems.

The symposium organised recently by the Biochemical Society upon "Biochemical Aspects of Genetics" would have delighted Hopkins, for he was convinced that in this direction lay the biochemistry of the future. Sufficient indication was available from the pioneer work of such investigators as Garrod and Onslow on multicellular organisms that there awaited a rich harvest to be gathered in the fullness of time, and the discussion here reported has further endorsed such an expectation.

The symposium was so organised that in the morning session, under the chairmanship of Prof. J. B. S. Haldane, the development was reviewed of our knowledge of colour inheritance and pigment production in flowers and the interpretation of chemical abnormalities encountered in man. The afternoon session, under Dr. A. Neuberger, dealt with chemical methods of inducing mutation, the relation between gene action and mutation, between spatial pattern as the geneticist understands it and the time sequences of biochemical processes, and finally with the problem of the relationship existing between genetic differences and the production of adaptive enzymes in micro-organisms. A wide field was thus covered, which served to point to problems for future resolution as well as frequently to indicate striking identity of conclusion by workers in the biochemical and genetical laboratory respectively.

That a simple relation must exist between genes and enzymes is, of course, an assumption essential to all this work on biochemical genetics; but the exact form of such relationship has still to be determined —whether, for example, one particular gene controls the elaboration of one particular enzyme, or whether the gene itself may not, indeed, be identified with the enzyme in question. The bulk of experimental and clinical evidence is in favour of the former one-to-one hypothesis; but it seems that the question of identity, or otherwise, may not be finally answerable until we know much more concerning the nature of adaptive enzymes and the mechanism of their formation.

Considering now in more detail each of the contributions to this symposium, W. J. C. Lawrence described how Onslow's suggestion that in *Antirrhinum majus* anthocyanins were derived from anthoxanthins led to the later investigations at the John Innes Institution which demonstrated that anthocyanin production was controlled as regards amount, state of oxidation, degree of methylation and glucosidal type by simple gene relationships, as were also flavone and chalkone production. Further, it was shown that in *Dahlia*, competition could exist between the production of anthocyanin, flavone and chalkone, according to gene dosage, implying the parallel production of these materials from a common precursor, a view which had previously been put forward on purely theoretical grounds by Robinson.

Prof. L. S. Penrose set forth Garrod's fundamental conception of certain disease states or metabolic anomalies as inborn errors of metabolism, and showed how such an analysis enabled an explanation to be given for the first time by Garrod of the special significance of inbreeding in man.

Prof. C. Rimington pointed out that Garrod's interpretation of familial conditions as being due to the lack of a particular enzyme essential for the completion of a certain stage in normal intermediary metabolism is probably correct in the case of alcaptonuria, and cited good evidence for believing tyrosinosis and phenylketonuria to be similarly interpretable. In familial methæmoglobinæmia, deficiency of a co-enzyme factor in the erythrocytes of affected persons has actually been demonstrated by Gibson. Certain of the conditions studied by Garrod, notably cystinuria, are better interpreted, however, as errors of retention or excretion. Thus cystine is only one of a group of substances showing some chemical similarity which are demonstrable in cystinuric urine, and it would appear that in this condition the kidney is unable to re-absorb certain constituents from the glomerular filtrate. A precisely similar explanation has been given by Friedman and Byers for the excretion of uric acid by the Dalmatian dog, and these workers produce compelling experimental evidence in support of their view.

The different classes of substance which are available for the chemical induction of mutation—mustards, carcinogenetic hydrocarbons, etc.—were discussed by Dr. J. G. Carr, who pointed out that all are radiomimetic. As yet no substances have been discovered which will react with only one gene.

Dr. D. G. Catcheside analysed the relationship between gene action and mutation. Some extreme mutations, in which loss of activity appears to be complete under all conditions within which the organism is viable, can back-mutate or revert to the wild type. This must mean that an almost intact gene, capable of reproduction, must have persisted. The most probable postulate is that specificity has been retained, but that the enzyme produced by the mutant gene suffers from a restricted stability, for example, as regards temperature or pH. In other cases back-mutations never occur.

Dr. G. Pontecorvo, after describing the modern techniques for the genetical study of moulds, bacteria, protozoa, etc., posed the question whether or not spectral organisation of genetical architecture is related to the time sequence of biochemical steps it controlled, in some such way as are operations along assembly lines. There is some suggestion that this may be so, but further specifically planned investigation is needed to prove this point.

In the concluding contribution, Dr. J. Monod dealt with the phenomenon of adaptation encountered in bacteria, and showed how, for example, in *E. coli* ML, a lactose-splitting enzyme, lactase, and a maltose-splitting enzyme, amylomaltase, may be induced to form within the cells by cultivating them upon the respective substrates. The same two enzymes are subject to genetic control, as is seen from spontaneous and induced mutations. These latter are independent of the state of adaptation of the cells.

It is clear that much remains to be done before such fundamental processes of the cell as those under discussion at this symposium are fully understood, but that already biochemistry and genetics have joined in a partnership from which both are bound to profit immeasurably. C. RIMINGTON

THREE HISTORICAL NOTES

By DR. D. McKIE
University College, London

Boyle's Library

THE Hon. Robert Boyle died on December 30, 1691, and some curiosity has been expressed from time to time in recent years about what was done with his books after his death. In that valuable bibliographical study of Boyle that has made every student of seventeenth-century science his debtor, Prof. John Fulton quoted an entry for April 1, 1692, from a diary, now in the Bodleian and possibly by Zachary Merrill, to the effect that Boyle's library contained "330 fol. 801 qtos. 2440 Oct and 12. most of y^m well bound. They may be had for 3 or 400£ (tho' worth 1000) because they must not be sold by Auction"[1]. It was a considerable collection. Later, Fulton quoted[2] a further reference through the discovery by Mr. J. C. Hindle, of the Bodleian, of an advertisement dated July 9, [1692], stating that: "The Library of the Honourable Robert Boyle, Esq; lately Deceased, will be sold by Retail, on *Monday* the *11th.* of this Instant *July*: Any Gentlemen or Others, may have the opportunity to View, and Buy what they please, at reasonable Rates. Attendance will be given at the late Lady *Ranelaugh's* House in the *Pell-Mell*, near St. *James's*, on *Monday*, *Tuesday* and *Thursday* next, from Nine a Clock in the Morning till Seven at Night." In explanation of the reference to "Pell-Mell", it is known that Boyle lived with his sister, Lady Ranelagh, in her house in Pall Mall; she predeceased him by a week.

From this announcement, says Fulton, the library was not sold until July 1692, and then not by auction, but privately. It would seem, therefore, that booksellers and others were invited to buy from the collection lots or items in which they were interested.

Recently a copy of Becher's "Novum Organum Philologicum" (Francofurti ad Mœnum, 1674) came into my hands with the inscription on the reverse of the fly-leaf, "R Hooke p^d 21^d. Mar.25.1693MF.", since verified as being in Hooke's handwriting. Reference to the fragment of Hooke's diary for 1688–93 confirmed the details of the inscription; for under that date he had recorded, "In MF Paid 1.9d for Bechers *Novum Organum philologicum*"[3]. Further reference to the diary for the same period brought to light a number of other interesting entries which indicate that Boyle's library was dispersed.

Two days before he bought Becher's book, Hooke "in MF saw many of Mr Boyles German chemicall books, also Bechers word-book"[4], which suggests that this copy of Becher's book may well have belonged to Boyle before Hooke, since Becher was a well-known writer on chemistry and since it was a scientific book, a kind of thesaurus of scientific terms in Latin and German. Boyle did not, so far as is known, have a book-plate and he did not inscribe his name in his books.

Four days previously, on March 21, 1693, Hooke wrote: "In MF I saw neer 100 of Mr Boyles high Dutch German Chymicall books ly exposed in Moorfeilds on the railes . . ."[5]. It seems, therefore, that some at least of Boyle's books were sold to a bookseller in Moorfields. Later, at Tom's coffee-house, Hooke, on March 28, 1693, "Read a *Catal.* of Morgans and Boyles books at Toms"[6]. Next day, he called at Tom's for a catalogue "for Mr Waller".

These entries by Hooke make it practically certain that Boyle's library was dispersed and that there is no hope of its now being recovered, as Newton's was.

The Descent of Pierre Joseph Macquer (1718-84)

Pierre Joseph Macquer (1718–84), compiler of the first dictionary of chemistry and professor of chemistry in the Jardin du Roi, is said to have been descended from a noble Scots family who had lost all for the Stuart cause and the Catholic faith. Macquer does not, however, seem to be a corruption of a Scots name; even if it were derived from Ker, the noble families of that name were not supporters of the Stuart cause[7]. It appears that Macquer's family came to France, not after the rising of 1715, but with James II in 1689 [8]. This would suggest the possibility of an Irish origin.

Search in the parish registers of St. Germain-en-Laye, the refuge of James II and his Court, reveals the name of Maguire, the family name of Lord Enniskillen, and in various spellings such as Magoire, Mackower, Magower, Makaire, Magaire and other forms, as well, of course, as the correct one[9]. In most cases the entries relate to members of the ill-fated house of Enniskillen. The peerage had been forfeited in 1645, when Connor, second baron, was hanged at Tyburn for his share in the rebellion (1641) of Owen Roe O'Neill. The family continued to use the title, and Roger, fifth baron, was appointed Lord Lieutenant of Fermanagh by James II in 1689.

The curious varieties of spelling in the registers of St. Germain leave no doubt of the possibility of the corruption of Maguire to Makaire. French pronunciation would make no difficulty in corrupting Maguire to Macquer. In fact, the Irish officer, Richard McGuire, who was associated with Richard Crosbie (1755–1800), the first Irish aeronaut, is described by Tissandier as "un jeune aéronaute nommé Quer"[10].

The established corruption in spelling and the descent from a noble family suggest, therefore, that Macquer may have been a descendant of the Maguires, Barons of Enniskillen, and of Irish, rather than Scots, origins.

Sir Thomas Browne and Biringuccio's "Pirotechnia"

The recent publication of a complete English version of the "Pirotechnia" (1540) of Biringuccio[11] has once again raised the question of the currency of this work in earlier times, and the alleged preference for the "De Re Metallica" (1556) of Agricola. The translators directed attention[12] to an entry in Hooke's diary for November 12, 1675 [13], referring to Biringuccio's treatise, but pointed out that known references to this great book are few. Another is, however, to be found in Hooke's diary under the date March 1, 1677/8, when Hooke acquired a copy for two shillings[13]. Attention is also directed to a further reference by Sir Thomas Browne in his "Hydriotaphia" (1658)[14], where he refers to the preservation of charcoal underground for more than four hundred years as described by Biringuccio[15].

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[1] Fulton, J. F., "A Bibliography of the Honourable Robert Boyle . . ." (Oxford, 1932), reprinted from the *Proceedings and Papers of the Oxford Bibliographical Society*, 3, pt. 1, 4.

[2] Addenda to a Bibliography of the Honourable Robert Boyle, 2–3 (Oxford, 1933) (reprinted from *ibid.*, 3, pt. 3).

[3] Gunther, R. T., "Early Science in Oxford" (Oxford, 1935), 10, 225. MF = Moorfields.

[4] *ibid.*, 224.

[5] *ibid.*, 223.

[6] *ibid.*, 225–26.

[7] Thomson, Thomas, "The History of Chemistry", 1, 295 (London, 1830).

[8] "Nouvelle Biographie Générale, 32, 595 (Paris, 1860).

[9] "The Parochial Registers of Saint Germain-en-Laye. Jacobite Extracts of Births, Marriages and Deaths", ed. C. E. Lart, 1, 4, 21, 25, 53, 93, 94, 108, 109, 139, 158, and 2, 16, 22, 23, 35, 67, 73, 82, 93, 102, 107, 163 (London, 2 vols., 1910–12).

[10] Tissandier, G., "Histoire des Ballons et des Aéronautes Célèbres, 1783–1890", 1, 103 (Paris, 2 vols., 1887–90).

[11] "The Pirotechnia of Vannoccio Biringuccio . . .", trans. C. S. Smith and M. T. Gnudi (New York, 1943).

[12] *ibid.*, p. xvii. See also "The Diary of Robert Hooke . . . 1672–1680", ed. H. W. Robinson and W. Adams, 193 (London, 1935).

[13] "Diary", 347.

[14] "Hydriotaphia, Urne-Buriall, etc.", 36 (London, 1658). "The Religio Medici and other Writings" (Everyman ed.), 113.

[15] "Pirotechnia" (English trans.), 177.

OBITUARIES

Prof. C. H. Lander, C.B.E.

Cecil Howard Lander was born at Stockport, Cheshire, in 1881. After receiving his early education at private schools in Cheshire, he decided to prepare for engineering as his career. His first step was to obtain practical training. To this end, on leaving school, he joined the engineering staff of the Manchester Ship Canal Company, then moved to become an assistant to the late Mr. Charles Hopkinson, and eventually was on the staff of Heenan and Froude, by whom he was employed on the design and testing of refuse destructors. In consequence, Lander had acquired a background of varied practical experience over about five years before he entered the University of Manchester in 1902 as a student in engineering. At the University his ability was soon recognized. He graduated in 1905 with first-class honours and was awarded the Fairbairn Prize.

On graduation, Lander continued as a research student. A year later he was appointed a demonstrator, and in 1910 was promoted to a lectureship in engineering in the University of Manchester, a post which he held until he joined the R.N.V.R. in 1916. Lander's research work while he was in Manchester included a series of investigations on problems of heat flow, surface friction and allied phenomena, on the results of which he was awarded the degree of M.Sc. in 1908 and D.Sc. in 1916. During this period he was also a part-time engineer to the Home Office in charge of experimental work on heating and ventilation for the Humidity Committees; this work was the basis of regulations since included in the Factory Acts.

During 1916–20 Lander served as a lieutenant in the R.N.V.R., and his important work in relation to several war-time requirements was recognized by an award on the recommendation of the Royal Commission on Awards to Inventors. On leaving the R.N.V.R. in 1920, Lander was appointed assistant to the director of fuel research (the late Sir George Beilby) in the newly established fuel research organisation of the Department of Scientific and Industrial

Research. Two years later he was promoted to the post of deputy director and in 1923, on the retirement of Sir George Beilby, he became director of fuel research, a post which he held until 1931. Under his guidance the fuel research organisation undertook important investigations on the carbonization and gasification of coal and coke, on the production of oil from coal by hydrogenation, and on many other fuel problems. In association with the late Dr. F. S. Sinnatt, he organised and developed the Physical and Chemical Survey of the National Coal Resources. In recognition of his work as director of fuel research, Lander was made a C.B.E. in 1928.

In 1931 Lander returned to academic life as professor of mechanical engineering at the Imperial College of Science and Technology, London, a post which he held with distinction until 1946. Under his guidance, based on his broad experience and deep interest in education, a high standard in the training of mechanical engineers was achieved. He also played a prominent part in the systematic training of chemical engineers, and was the first chairman of the Board of Studies in Chemical Engineering in the University of London. The branch of research in which he was most keenly interested was that in relation to problems of heat transfer, on which he led and inspired teams of investigators for more than twenty-five years. His notable papers on the subject included that which he presented to the Institution of Mechanical Engineers in 1942, and for which he was awarded the Hawksley Gold Medal and Premium.

During the Second World War, Lander's experience and ability were invaluable. He played a great part in the development of gas turbines and jet propulsion, flame-throwers, and oil burners (F.I.D.O.) for the dispersion of fog over airfields. His merit in this kind of work lay not only in the way he guided and inspired investigators under his immediate control, but also in the facility with which he co-ordinated the work of several teams under different leaders and ensured harmonious co-operation from all in achieving results rapidly.

Of the many organisations indebted to him for advice and help, only a few can be mentioned as examples. He was for many years vice-chairman of the British National Committee of the World Power Conference, a member of the Safety in Mines Research Board, a member of the Mechanical Engineering Research Board of the Department of Scientific and Industrial Research, and chairman of several wartime scientific committees. For two years, 1946–48, he was president of the Institute of Fuel and was awarded the Melchett Medal of that Institute in 1945.

On retiring from the professorship of mechanical engineering at the Imperial College in 1946, he accepted an invitation to become dean of the Military College of Science at Shrivenham, with the task of re-organising the College as the principal establishment for training army officers in the military applications of science and technology. In this new sphere of activity, Lander had already achieved notable success. It was while he was engaged on this work that Lander died suddenly at Shrivenham on March 17.

Apart from his professional work, Lander had other interests, including music; and he had looked forward to spending more time at his house at Shepperton and with his motor launch on the Thames. Of a kindly nature, he will be missed by his many friends and colleagues. A. Parker

In October 1946, Dr. Lander became dean of the Military College of Science, which was re-assembling after the War at Shrivenham in Wiltshire and was expanding its scope to prepare officer students for external degrees in science and engineering of the University of London as well as to train officers for the technical staff of the Army.

The re-organisation necessary to enable the College to carry out these extended functions at the same time as it was being reconstituted involved an enormous amount of work in the remoulding of the faculties, in discussions with the University of London, in the preparation of syllabuses and in the recruitment of lecturing staff. The co-ordination of this work in the College fell upon Dr. Lander, and his energy and enthusiasm and his connexions with the University contributed in great degree to the reconstitution of the College. That within two and a half years of its re-opening the first technical staff course passed out and the first degree courses took Part I of their degrees at London was largely due to his untiring work.

His wide contacts with the academic world resulted in the best of advice being available to the College, and his strong support of a policy of insistence upon high academic standard has laid sound foundations for the future.

Apart from his work on the academic side, Dr. Lander was a keen supporter of the sports and cultural activities of the College. He was a leading performer in the Musical Club and led the College orchestra.

But the quality by which he will be most remembered in the College was his kindly wisdom. In an assembly of soldier students and of academic and soldier teachers, most problems are viewed from several points of view and divergent opinions are strongly held. That varying opinions have been reconciled and canalized into channels which furthered the objects of the College has been in no small degree due to Dr. Lander's unfailing wisdom. His counsel both in wider policy and in day-to-day detail was invaluable, and the Military College of Science will look back on its first dean, with feelings of gratitude and deep affection, as one of the main founders of its modern constitution. W. J. Eldridge

Mr. H. E. Hadley

Mr. H. E. Hadley, well known as the author of many elementary text-books of physics, died on March 6, at the age of eighty-two. Mr. Hadley had lived rather a retired life. He was appointed headmaster of a small science school in Kidderminster, where he combined with physics a lectureship in chemistry. In those days, physics was considered of less importance than chemistry; but Mr. Hadley was always at heart a physicist. In spite of the almost total lack of physical apparatus, he made physics the career of three of his early pupils, for in three successive years his students gained national scholarships at the Royal College of Science, London, now the Imperial College of Science and Technology, a rather unique success for a small school.

Mr. Hadley was a contemporary of Sir Richard Gregory and H. G. Wells at the same College, and from his training there and association with C. V. Boys he acquired a special genius for making his own physical apparatus. His teaching equipment at Kidderminster was largely of his own making, and it would seem that this gave physics an added attraction to his students. Evidence of his ingenuity in this direction is apparent in his books.

In 1898 he wrote his first text-book, on "Magnetism and Electricity for Beginners". This was the first of several text-books produced in association with Sir Richard Gregory, which are known to generations of physics students. Much of his time thenceforward was devoted to the preparation of these books, while he still continued his teaching, from which he only recently retired after a period of more than fifty years. He maintained his interest in his books to the end, devoting much care to keeping them abreast of modern developments.

Mr. Hadley had a charming personality, and he was regarded with affection by those who benefited from his instruction.

W. S. TUCKER

WE regret to announce the following deaths :

Mr. Will Hay, well known as an actor and also a distinguished amateur astronomer, on April 18, aged sixty.

Mr. R. A. Todd, a Ministry of Agriculture and Fisheries inspector and formerly a member of the staff of the Plymouth Laboratory of the Marine Biological Association of the United Kingdom.

NEWS and VIEWS

Meldola Medal for 1948 : Dr. R. A. Raphael

ON the recommendation of the Council of the Royal Institute of Chemistry, the Society of Maccabæans has awarded the Meldola Medal for 1948 to Dr. Ralph Alexander Raphael, in recognition of the contributions he has made to the investigation of new methods of approach to the synthesis of natural compounds. Dr. Raphael graduated in 1941 from the Imperial College of Science and Technology with first-class honours in chemistry, and in 1943 was awarded a Ph.D. for work on acetylenic compounds. During 1943–46 he was head of one of the chemotherapeutic research departments of Messrs. May and Baker, Ltd., and was mainly concerned with penicillin chemistry. He was then awarded an Imperial Chemical Industries fellowship and resumed research work at the Imperial College on the investigation of the potentialities of acetylenic compounds in the synthesis of natural products. In 1947 this work resulted in the total synthesis of the penicillic acid, thus proving its structure beyond doubt. Attention was then turned to the utilization of the peculiar properties of acetylenic compounds to accomplish the synthesis of carbohydrates and their derivatives, and, up to the present, arabitol, ribitol, erythritol, threitol and erythrulose have been obtained. A study is also being made of methods of producing long-chain aliphatic acids of various types. Concurrently, Dr. Raphael is also investigating synthetic routes to compounds containing the vitamin D triene system. He has recently been appointed lecturer in organic chemistry in the University of Glasgow.

Avenue of Human-headed Sphinxes at Luxor

IT has long been known that the avenue of ram-headed sphinxes of Amenophis III which extends southwards from the Temple of Khons at Karnak is the northern end of a processional way once linking the Temple of Karnak with the Temple of Luxor about one and a half miles to the south. On the line of this avenue, Zakaria Effendi Ghoneim, chief inspector of antiquities for Upper Egypt, has recently found a further series of human-headed sphinxes erected by either Nectanebo I or II about a thousand years later, in the late fourth century B.C. The main interest of the new discovery appears to lie, for the moment at least, in the inscriptions on the base of each sphinx. The text records that Nectanebo had "made this road for Amun so that he might make good navigation from Luxor". The god Amun was normally resident at Karnak. The principal occasion on which he visited Luxor was during the annual festival of Opet, when he was conveyed by river from Karnak to Luxor and the whole city was given over to festivity for many days. The new texts, therefore, either hint that by the end of the Pharaonic period the river journey of Amun during the Feast of Opet had been replaced by a progress by land, or they refer to a new or unidentified Theban feast. As the clearance and excavations round the Temple of Luxor progress, there is every reason to expect that new discoveries will be made, and that fresh light will be thrown on the early history of Thebes.

Additional Remains of *Australopithecus* in South Africa

FURTHER discoveries of the remains of the fossil Australopithecinæ of South Africa are now reported from a new site, Makapansgat, almost 250 miles north of Sterkfontein, where Dr. R. Broom found numbers of skulls and portions of the limb skeleton during 1947 and 1948. Two of the Makapansgat specimens, which have already been described by Prof. R. Dart in the *American Journal of Physical Anthropology* (6, 259 and 391 ; 1948) and referred by him to a new species, *A. prometheus*, consist of an occipital bone and an immature mandible. These provide additional confirmation of the inferences based on the earlier material that the Australopithecinæ show in certain anatomical features a remarkable approximation to those hitherto regarded as distinctive of the Hominidæ. For example, the disposition and extent of the nuchal crest and muscular markings on the occipital bone conform to the human rather than the simian type. The perfectly preserved and unworn anterior premolar in the immature mandible is bicuspid with the cusps of approximately equal height as in man, and thus differs markedly from the characteristic sectorial form of the lower anterior premolar in the anthropoid apes. Still more recently, there have been found at the same site a considerable part of the facial skeleton, a parietal bone, and the iliac portion of a pelvis. According to unpublished reports, the ilium, like the specimen already described by Broom (*Nature*, 160, 430 ; 1947), is closely similar in shape and proportions to a human ilium, and thus contrasts strongly with that of apes.

Science Museum, London

DEMOLITION of the old portion of the Science Museum, London, known as the Southern Galleries, has now commenced. This building, which had recently become extremely dilapidated, was erected as a temporary structure for the International Exhibition of 1862, and continued to be used thereafter by the Science Museum for exhibition purposes until the beginning of the War in 1939. For many years these galleries have been scheduled for destruction, and owing to their susceptibility to fire and bomb damage were a source of considerable anxiety during the War. The main portion of this old building is now being demolished to make room for a new centre block for the Science Museum, on the roof of which a planetarium is to be erected. It is anticipated that the ground floor and basement of this new building will be available in time to accommodate the science and technology portion of the Festival of Britain Exhibition in 1951. After this, work on the building will be continued and the building when completed will form the centre block of the Science Museum, with four floors of exhibition galleries. Arrangements for the occupation of this portion of the Science Museum are well under way, and it is anticipated that long before this additional accommodation becomes available, detailed arrangements for the display of specially appropriate and attractive exhibits will have been completed.

Scientific Instruments of George III

While he was still Prince of Wales, the future King George III showed much interest in mechanics, optics, astronomy and scientific experiments of all kinds. Thus encouraged, the leading instrument makers of the second half of the eighteenth century constructed many models and apparatus for the instruction of the Prince. As might be expected, these models illustrate the craftsmanship of the period, and collectively they convey a remarkably clear impression of the general field of scientific study and experiment at that time. Fortunately, the instruments were preserved as a collection, and for many years they were kept at Kew Observatory. They were used again for instructing the many children of George III, and in 1841 they were presented to King's College, London. The collection was loaned to the Science Museum in 1926, but since 1928 it has been in store on account of the lack of space. It has now been placed on exhibition again and may be seen, until the end of September, at the Science Museum, South Kensington, London, S.W.7. Historically, the exhibition is of interest, as it covers an important era in scientific development—an era which witnessed the growth of modern physics and chemistry from the 'black magic' and haphazard alchemy of the Middle Ages, the development of such instruments as the thermometer, and great advances in the study of electricity. Science was becoming popular, but at the same time the foundations were being laid for progress on logical lines of experimental and theoretical philosophy. The course of instruction and the experiments performed tended to follow closely the lines laid down half a century earlier by the Dutch philosopher 'sGravesande, himself a disciple of Sir Isaac Newton, and one of the gems of the present exhibition is the 'Philosophical Table', which is similar to that designed by 'sGravesande. In the parlance of this more vulgar age, a 'philosophical table' is a 'laboratory bench'. Other items worthy of special note are the vacuum pumps made by George Adams and two fine microscopes constructed about 1750.

Commission on South African Museums

Last year, in *Nature* of November 27, p. 861, it was reported that the Government of the Union of South Africa had set up a Commission to inquire into the financial position of certain State-aided institutions which, it was then understood, included certain museums, art galleries and zoological gardens. An announcement in the *Government Gazette* (*Pretoria*) for March 4 of this year extends the field of inquiry, and lists the institutions concerned, as follows: the South African Museum, Cape Town; the Transvaal Museum, Pretoria; the Natal Museum, Pietermaritzburg; the Orange Free State Museum and Monument Museum, Bloemfontein; the Voortrekker Museum, Pietermaritzburg; the South African War Museum, Johannesburg; the South African National Art Gallery, Cape Town; the Michaelis Collection, Cape Town; the National Zoological Gardens, Pretoria; and the National Botanical Gardens, Kirstenbosch.

The inquiry now covers not only the financial aspects of these institutions, but also their organisation and activity. The Commission is directed to make investigations and recommendations regarding the co-ordination of the research carried out by each institution; the possibility of co-operation between the named institutions, universities and other institutions towards a greater economy and efficiency in the preparation of material for exhibition and educational purposes; the advisability of forming a national board of trustees, or similar organisation, for the co-ordination of the work of the named institutions; the advisability of co-ordinating the research and education functions of the institutions and certain others not State-supported; the advisability of all or some of the named institutions becoming full State institutions; the incorporation of war museums in other museums; and the establishment of a science museum in Johannesburg. If the Commission finds that the last-mentioned is desirable, it is asked to make recommendations for its organisation and control. For the purpose of the inquiry outlined above, the Commission is given full authority to consult any person and Government book, record, etc. The wide scope of the inquiry and its importance demonstrate the formidability of the Commission's task, and it is indicative of a strong Government interest which will ultimately not only strengthen the efficiency of the Union's museum services, but will also point the way to even further developments.

Survey of India: Annual Report

The Survey of India has issued a Civil Activities Report covering the period April 1, 1945–March 31, 1946, which replaces the detailed General and Geodetic Reports which have been in abeyance since 1939 but are to be introduced for the year 1946–47. Much of the work of the Survey during the year was directed towards the furtherance of a number of long-term projects, such as the Kosi, Mahanadi and Tista irrigation schemes. For these schemes somewhat rigid priority assessments had to be made owing to the shortage of men and instruments, and new and cheaper survey expedients were adopted to provide preliminary information. Even so, the routine topographical programme received scant attention. With the widespread resumption of civil surveys, the concentration of resources in Dehra Dun has been reversed, and the Eastern Circle controlling work in Assam, Bengal, Bihar and Orissa has been re-established in Shillong. The Southern Circle has been re-created; but map publication is still largely concentrated in Dehra Dun, where also the projects officer is located. No new or revision topographical surveys or forest surveys were carried out during the year; but two settlement surveys were undertaken in the hilly districts of Kulu and Almora. Considerable progress has been made in replenishing stocks of quarter-inch maps corrected up to date; but for one-inch maps the present policy is to reprint the maps uncorrected pending the opportunity for surveying the necessary corrections. The series comprises 4,100 sheets, and in issuing corrected editions a start will be made with the most developed regions.

War experience as well as post-war activities have shown the need for a strong scientific body largely free from administrative responsibilities to enable the Survey of India to keep abreast of scientific thought and developments. The proposed Survey Research Institute, replacing the War Survey Research Institute, when constituted, will carry out the scientific functions of the Survey, and will also collaborate with the National Physical Laboratory, particularly in respect of standards of length and time. The Institute will be staffed and organised for work on measurements of length; standardization of measuring tapes, etc.; astronomical work as applied to latitude, longitude and time; tidal work; and magnetic observations. During the year the War Survey Research Institute carried out further investigations on the improvement of base-measurement apparatus and devised new methods of rapid fixation of position from stellar observations.

Linen Research Association: Report for 1948

THE Linen Research Association, which is at Lambeg, Co. Antrim, has recently issued its annual report for the year ended September 30, 1948. The report records the opening of the new buildings in June; the installation of plant and equipment in the new technical shed for bleaching, dyeing and finishing is now almost complete. Delivery of machinery for the weaving section has also begun; but difficulties in recruiting well-qualified scientific staff have continued, although the accommodation for the increased staff planned in 1945 is now available. In view of the fall in home flax production, it is considered essential to continue research on flax production and to make another serious attempt to increase the yield of flax obtained from scutching. The total number of members is now 280, and the report includes lists of both members and staff and of the membership of committees. Research work carried out during the year has included a continued study of the effect of varying the retting process on the yield and quality of fibre produced from different types of straw, and also a study of the prevention of deterioration of the retted straw during drying. An investigation on a standard turbine scutching-machine has shown that low humidity has little effect on yield provided the straw contains about 14 per cent of moisture, but it greatly reduces the yield if the straw is dry; while at 85–90 per cent relative humidity in the turbine, dry straw can be scutched with a yield only slightly lower than that with properly conditioned straw. The investigation for the Ministry of Supply on the relation between fibre properties and yarn quality has been completed, and an investigation of 'dropped ends' has been started to determine the factors which limit the rate of production and the efficiency of spinning frames. Weaving tests have continued on a variety of yarns in automatic looms of the shuttle-change and pin-change types. Work on cloth bleaching has aimed at modifying existing processes to whiten fabrics with no degradation of the cellulose, and to secure the maximum durability; while work on dyeing has led to an improved method of securing penetration of vat dyes in linen fabrics.

Analysis of Management

IN his paper, "The Nature of Management", based on an address to the London and District Society of Chartered Accountants, and now issued as "Occasional Papers No. 2" by the British Institute of Management, Sir Charles Renold insists that management is directed to action and that the action is at second-hand: management is concerned with guiding the actions of people other than the planners or guiders. Accordingly he regards management as fundamentally the process of getting things done through the agency of a community, and the functions of management as the handling of a community with the view of its fulfilling the purposes for which it exists. A large part of those functions is, in fact, concerned with the well-being of the team or community, and, in pursuing that well-being, the particular purpose of the community may be only of very indirect consideration. Sir Charles examines in some detail the requirements of community well-being so far as they are yet understood, emphasizing the importance not only of the structure or organisation of the community and procedures but also of their acceptance by the individuals forming the community. Contentment will not be secured unless there is confidence that rules and discipline are administered fairly, and the processes of using the team or community to achieve its purposes really turns on devising instructions appropriate to the situation. Planning he regards as a group of processes providing the raw material from which operative instructions are fashioned, and control as seeing how the plans are working out with the view either of modifying them or of improving the response of the community when necessary. Accountancy is one of the indispensable techniques of management; but he points out that every official in the course of his executive duties has to make decisions which are of the nature of policy, and the readiness to accept responsibility for making such decisions and the ability to make wise ones are as important elements in the qualifications of an official as is loyal compliance with orders. The statement that policy-making is the business of the board of directors and execution that of the management should not be accepted uncritically; and Sir Charles distinguishes policy-making as the establishment (not necessarily the origination) of an overall pattern of rules and principles from the development of these rules and principles into greater detail, and execution as their application to particular situations.

Problems in Astronomy

THE Cawthron Lecture for 1947, with the title of "Problems in Astronomy, Solved and Unsolved", was delivered by F. G. Gibbs, curator of the Atkinson Observatory, Nelson, N.Z., and gives a very useful survey of the progress of astronomy during the last two decades. Some space is devoted to an examination of the theories of the source of stellar energy, and a short description is given of Bethe's carbon-cycle theory which is now generally accepted. A consideration of variable stars leads to the past history of the sun, the heat of which has been shown by geological evidence to have varied considerably during the last 1,000 million years. Simpson's pluvial theory is dealt with—a theory which assumes that increased precipitation of moisture in the form of rain and snow was due to an increase in the heat of the sun—but no satisfactory explanation has yet been given of the cause of the variation in the sun's heat. Regarding novæ and super-novæ, no explanation is suggested beyond the statement that "atomic energy has no doubt something to do with it". Among some of the problems still awaiting solution are the origin of the solar system, the evolution of the stars, the structure and evolution of the universe, and cosmic rays. This lecture provides a very helpful summary of the progress of astronomy in comparatively recent times and also of the problems still awaiting solution, some of which appear more intractable now than they did twenty years ago.

Royal Scottish Museum : Natural History Department

With the re-opening of the Beasts of Prey Hall, the main halls and galleries belonging to the Natural History Department of the Royal Scottish Museum, Edinburgh, are now available to the public. These number twelve in all, allocated as follows : British fauna (2), mammals (3), extinct animals (1), foreign birds (1), amphibians and reptiles (1), fishes and molluscs (1), entomology (1), biology (1), and children's gallery (1). In addition, the study room, for use of students of the collections, is now open. During the War, many of the collections were removed, and the opportunity has now been taken to re-arrange much of the material. In addition, two specialist galleries for students are in use. An introductory hall entitled "The Story of the Earth", serving as an introduction to natural history and geology, is in course of preparation. A gallery of marine invertebrates is projected.

Universal Decimal Classification

The first abridgment of the full universal decimal classification in English has been published by the British Standards Institution as B.S. 1000 A. : 1948. It consists of 128 pages and costs 25*s*. It is intended for use in libraries or private collections where detailed subdivision of subjects is not required, or in special libraries using the full classification in a given subject but requiring an abridged classification for other fields. It is based on the official abridgment in the Dutch language, fifth edition, with the help, mainly in the sciences, of the abridgment published by H.M. Stationery Office, under the title "Classification for Works in Pure and Applied Science in the Science Museum Library", third edition. The abridgment should form a useful introduction and guide to the complete fourth edition in English, which is being published by the British Standards Institution, section by section.

Correction of Magnesium Deficiency in Tomatoes

Magnesium chlorosis is widespread among tomatoes grown under glass in Great Britain. It probably causes a considerable loss of yield, and economic methods for its correction are therefore urgently required. D. J. D. Nicholas shows (*J. Hort. Sci.*, 24, No. 1, 1–18 ; June 1948) that this can best be accomplished by sprays of two per cent of magnesium sulphate applied to the foliage five times at intervals of two or three weeks. This results in the application of less than 5 cwt. per acre, compared with 10–20 cwt. of calcined kieserite, found necessary for soil applications. Soil factors probably immobilize a large proportion of the soil dressings of magnesium sulphate. Interactions of magnesium with potassium and nitrogen are also discussed in the paper.

Chelsea Polytechnic

The fifty-third annual report of Chelsea Polytechnic is interesting because of the attractive way in which its items have been presented. Besides the usual information about the number and range of classes and examination successes, the report contains a detailed analysis of the occupations of evening students, the geographical distribution of students, the kind of research undertaken by advanced students and particulars of services rendered by members of the staff in a voluntary capacity to various kinds of learned and other societies. The examination statistics show that, during the last two years, one D.Sc., five Ph.D.s and seventeen M.Sc.s were obtained, figures of considerable significance for those who wish to see some evidence that the recommendations of the Percy Committee on Higher Technological Education have not been forgotten. This report, so clearly and precisely presented, is a fine example of what such a document can be in building up the corporate spirit of a large institution.

New Zealand Earthquakes during October 1948

Nine strong distant earthquakes were registered during October 1948 by the New Zealand seismographs situated at Auckland, Arapuni, Christchurch, Kaimati, New Plymouth, Tuai and Wellington, according to the report from the Dominion Observatory, Wellington. In addition, eighteen earthquakes and tremors were felt by people in New Zealand during the month. The greatest of these had instrumental strength 4½ and was felt at Dunedin and Monowai on October 9. The next most intense had instrumental strength 4¼, and these were felt on October 16 at Otaki and Wanganui, and on October 29 at Hanmer Springs.

Editorial Board of *Chymia*

The University of Pennsylvania Press has announced the appointment of Henry M. Leicester, professor of biochemistry, College of Physicians and Surgeons in San Francisco, as editor-in-chief of *Chymia : Annual Studies in the History of Chemistry*. Dr. Leicester, who succeeds the late Tenney L. Davis as editor, is chairman of the History of Chemistry Division, American Chemical Society, and associate editor of the *Journal of Chemical Education*. Prof. John Read, professor of chemistry and director of the Chemistry Research Laboratory, University of St. Andrews, is the new associate editor of *Chymia*. Other members of the editorial board are : Claude K. Deischer, Rudolf Hirsch, Herbert S. Klickstein and Eva V. Armstrong.

University of London : Appointments

The following announcements of appointments have recently been issued : Prof. H. C. Darby has accepted an invitation to the University chair of geography tenable at University College, and Mr. W. O. Lester Smith to the University chair of sociology of education tenable at the Institute of Education, both as from October 1, 1949. Dr. P. E. Vernon has been appointed to the University chair of educational psychology tenable at the Institute of Education, as from October 1, 1949. Appointments to readerships: Dr. E. T. Eady to the University readership in physical climatology tenable at the Imperial College of Science and Technology, as from October 1, 1949; Dr. A. J. Marshall to the University readership in zoology and comparative anatomy tenable at St. Bartholomew's Hospital Medical College, as from October 1, 1949; Mr. N. H. Martin to the University readership in chemical pathology tenable at St. George's Hospital Medical School, as from April 1, 1949; Dr. J. R. Raeburn to the University readership in agricultural economics tenable at the London School of Economics, as from October 1, 1949; Dr. J. W. Smith to the University readership in chemistry tenable at Bedford College, as from October 1, 1949.

University of Bristol: Appointments

DR. H. S. HELLER, reader and head of the Department of Pharmacology and Practical Pharmacy in the University of Bristol, has been appointed the first occupant of the new chair of pharmacology in the University. Dr. H. A. Heilbronn, reader in pure mathematics in the University, has been appointed to succeed Prof. H. R. Hassé as Henry Overton Wills professor of mathematics. Both these appointments take effect in the session 1949–50.

Announcements

THE Stamp Memorial Lecture will be given at the Senate House, University of London, by Prof. A. C. Pigou, emeritus professor of political economy, University of Cambridge, on May 13 at 5.30 p.m.; he will speak on "Wage Statistics and Wage Policy". Admission is free, without ticket.

THE Silvanus Thompson Memorial Lecture for 1949 of the British Institute of Radiology will be delivered by Dr. F. G. Spear, of the Strangeways Research Laboratory, Cambridge, at the Institute on April 28; he will speak on "The National Radium Commission in Retrospect".

THE thirty-seventh Wilbur Wright Memorial Lecture of the Royal Aeronautical Society will be given by Dr. Hugh Dryden, director of aeronautical research to the National Advisory Committee for Aeronautics, at the Royal Institution, London, on April 28 at 6 p.m.; Dr. Dryden will speak on "The Aeronautical Research Scene—Goals, Methods and Accomplishments".

IN connexion with the series of lectures on the "Development of Taxonomy" given at the rooms of the Linnean Society during the past winter, there will be a demonstration at the Herbarium, Royal Botanic Gardens, Kew, on May 7 at 2.30–5 p.m. The demonstration, which has been arranged by the Linnean Society and Systematics Association, will illustrate the history and methods of botanical taxonomy from 1753 to the present day, and is primarily intended for advanced university students and teachers.

DR. T. W. PARKER has recently been appointed deputy director of building research in the Department of Scientific and Industrial Research. Dr. Parker, who was educated at the University of Durham, joined the staff of the Building Research Station in 1930. His research work has been mainly concerned with building materials and their use in structures. For some years he was also responsible for the Station's programme of work at the Fire Testing Station, Elstree, before this was taken over by the Fire Research Organisation of the Department.

THE Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1949–June 1950. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. N. B. Marshall, British Museum (Natural History), London, S.W.7, before the end of May.

AN award is to be made of the studentship in experimental and mathematical aeronautics research established in memory of Edward Teshmaker Busk, who in 1914 lost his life while flying an experimental aeroplane. The studentship, which is worth £165 and tenable for one year at the University of Cambridge, is open to any British man or woman less than twenty-five years of age. Full details may be obtained from the Professor of Aeronautical Engineering, Engineering Laboratory, Cambridge.

THE Medical Research Council is offering the following travelling fellowships for the academic year 1949–50: Rockefeller medical fellowships for postgraduates resident in Great Britain to work in the United States or elsewhere; Dorothy Temple Cross research fellowships in tuberculosis for British subjects to work elsewhere than in Great Britain. Both fellowships are worth £650 per year and there are travelling allowances and a £250 marriage allowance. Application forms, to be completed by June 1, may be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

AN exhibition of calculating machines and equipment will be held in the Firth Hall, University of Sheffield, during April 29 (2.30–8.0 p.m.) and April 30 (10.0 a.m.–6.0 p.m.). The exhibition will be opened by Prof. D. R. Hartree, Plummer professor of mathematical physics, University of Cambridge, who will speak on "Some Recent Developments in Calculating Machines". Lectures will also be given by Mr. G. B. Hey (Trustee Department, District Bank, Ltd.) on "Applications of Punched Card Machines in Accounting and Scientific Computing", and Dr. E. T. Goodwin (Mathematics Division, National Physical Laboratory) on "Calculating Machines: their Nature and Applications". Admission is free.

THE Coal Tar Research Association, now incorporated under the Companies Act of 1948, has leased premises at Gomersal, near Leeds, for its research station. It is expected that the headquarters of the Association will move from the present address, 9 Harley Street, London, W.1, in June and that the laboratories will be completed later in the year.

THE National Physical Laboratory at Teddington is holding an 'open day' on May 26 from 2.30–6.0 p.m., to which representatives of industrial organisations are being invited. This is an opportunity for members of industry to see the wide range of scientific research and investigational work undertaken at the Laboratory, and a number of tickets is being reserved for postal applications. Accredited representatives of industrial organisations who would like to visit the Laboratory and who are not already in contact with its work are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than May 14.

ERRATUM.—In the communication entitled "Shape Factor in Particle-Size Measurement" in *Nature* of April 2, p. 527, line 5 from end, for "K is then the standard deviation" read "K_2 is then the standard deviation . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Optical Properties of Barium Titanate

A PAPER by Kay in the *Acta Crystallographica* for November 1948 has just appeared which traverses ground so close to that which we have been exploring during the past two years that it seems desirable to announce at once a few points which seem to be both new and interesting in our work.

In 1946 one of us (R. W.) observed that 'Barkhausen clicks' occurred when a commercial ceramic titanate condenser (Dubilier) was electrically connected in a suitable circuit. We then, in pursuit of the problem, prepared single barium titanate crystals and examined them in polarized sodium light under various conditions of temperature (−5° to 140° C.) and in electric fields up to about 30,000 volts/cm. The well-known twinning (101 and 011 types) was immediately apparent in our small crystals, and in Fig. 1 is shown a scale model of just one example built up on an actual photograph (× 500). This photograph with its legend is self-explanatory.

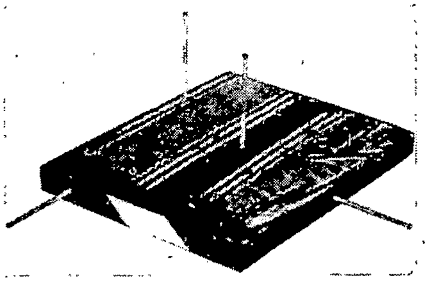

Fig. 1. Scale model of a typical crystal with pins indicating the direction of the optic axis in the twin components

The application, at room temperature, of an electric field of sufficient strength causes the c-axis to turn into the field direction throughout the crystal, a change usually achieved by the growth of small wedge-shaped needles lancing out at 45° from a crystal edge, which, when long enough to extend right across, begin to expand at right angles to their length, finally devouring the whole crystal. This movement may be quite slow, lasting minutes, and is often accompanied by light and dark lines which appear transiently, parallel to the c-axis, when viewed between crossed Nicols near the extinction position. At a twin boundary, these transient lines turn abruptly through 90°, as shown in Fig. 2, which, for reasons we cannot here elaborate, was taken in an alternating field at room temperature. It is thought that this phenomenon may be connected with a change of spontaneous polarization through 180°, these two directions being optically indistinguishable in the steady state.

Fig. 2. Crystal observed near the extinction position in an alternating field of 20 kV./cm. (× 750)

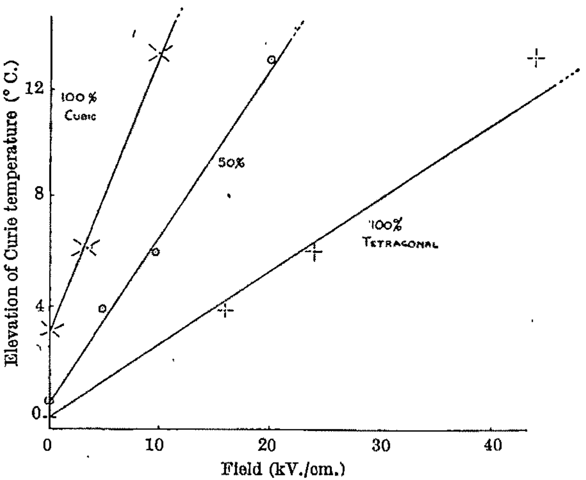

Fig. 3

We have specially examined the behaviour of these small crystals in the neighbourhood of the Curie temperature, the highest value of which was found to be about 121° C. At this temperature the structure changes from tetragonal to cubic; but this transition is inhibited by the application of an electric field, so that with fields approaching breakdown the transition does not occur until as high a temperature as 130° C. is reached. This effect, which has its counterpart in ferromagnetics, is approximately summarized in Fig. 3.

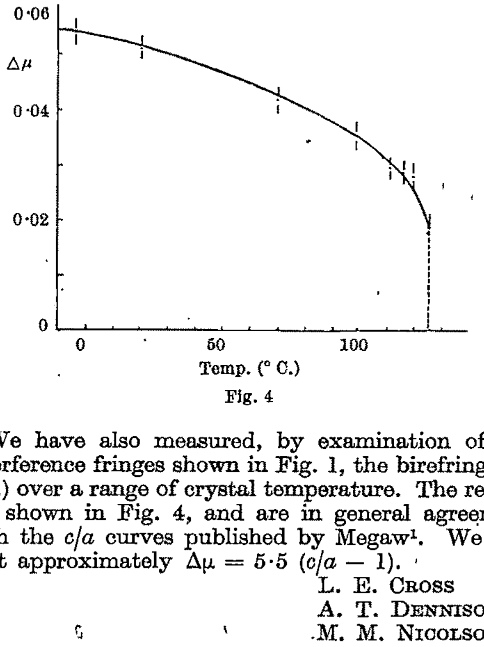

Fig. 4

We have also measured, by examination of the interference fringes shown in Fig. 1, the birefringence ($\Delta\mu$) over a range of crystal temperature. The results are shown in Fig. 4, and are in general agreement with the c/a curves published by Megaw[1]. We find that approximately $\Delta\mu = 5{\cdot}5\,(c/a - 1)$.

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Dec. 16.

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[1] Megaw, H. D., *Proc. Roy. Soc.*, A, 189, 261 (1947).

Atomic Positions and Optical Properties of Barium Titanate

In view of recent discussion[1,2] of possible departures of some of the atoms of tetragonal barium titanate from the centrosymmetrical configuration of the unit cell (Ba^{+2} at 0, 0, 0; Ti^{+4} at $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$; O^{-2} at $\frac{1}{2}, \frac{1}{2}, 0$; $\frac{1}{2}, 0, \frac{1}{2}$; and $0, \frac{1}{2}, \frac{1}{2}$), the following may be of interest. Oscillation photographs of an untwinned crystal of nearly square cross-section (12 : 13) have been obtained, and reflexions of the type $h,0,0$, $0,0,l$, examined. No intensity differences between these pairs of reflexions have been observed by eye, and from this it is concluded (using F values obtained from the International Tables) that there is no simple shift of the Ti^{4+} ion parallel to the c-axis by more than 0·05 A. or of the O^{2-} ion at $\frac{1}{2}, \frac{1}{2}, 0$ by more than 0·13 A. from the above positions.

Since movements of this magnitude cannot account for the observed value[3] of the dipole moment of the unit cell, this (if its value is confirmed) must result in the main from an effective displacement of outer electrons only, arising from some system of partly polar bonds such as has previously been suggested[1]. We may add here that oscillation photographs of crystals of the hexagonal modification of barium titanate have also been obtained which show that this has a slightly more open structure than the tetragonal form, and that the lengths of the Ba—O and Ti—O bonds are again different in different directions.

It is hoped shortly to establish the exact parameters of the tetragonal crystal to a higher degree of accuracy with the aid of Weissenberg photographs.

The uniaxial character and orientation of twins in barium titanate have been confirmed by optical observation between crossed Nicols, using a quartz wedge.

Observations on thin plate-like crystals having their tetragonal c or optic axis in the plane of the plate have shown that the usual method of twinning often results in a pair of boundaries having a separation of approximately 10^{-4} cm. Such pairs or 'double boundaries' may terminate within the crystal by oblique junction, or may extend right across it with constant separation. The enclosed material has its optic axis perpendicular to that of the adjacent twins and also in the plane of the plate, so that an isolated 'double boundary' consists of a thin lamella of material having its polar direction perpendicular to the rest of the crystal (Fig. 1). The double-boundary separation appears to be independent of the crystal thickness and shape, and to have a minimum value of approximately 2×10^{-4} cm. This twin formation is one which will relieve internal shear stresses in a crystal and will result in minimum change in external shape.

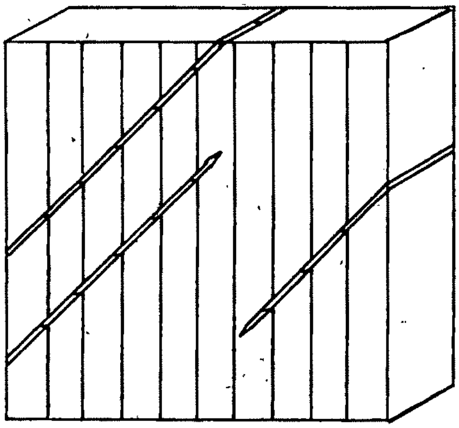

Fig. 1. Twinning in $BaTiO_3$ crystals; shading shows direction of c axis

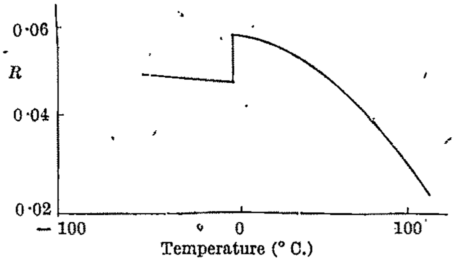

Fig. 2. Birefringence curve for $BaTiO_3$

The birefringence (R) has been measured for a large number of crystals by a rapid method, using white light. The absolute value varied from 0·50 to 0·59 at 30° C. The variation of (R) in the temperature range − 50° to 120° C. was also measured for a few crystals by a compensation method using filtered radiation. Fig. 2 shows the relation between the birefringence (R) and temperature (θ). The curve between − 5° C. and $\sim$ 120° C. fits the equation $(K - R) = \alpha(T - \theta)^2$, where $K = 0{\cdot}62$ is the maximum value of R at $\sim -$ 5° C. and R changes discontinuously; α is a proportionality constant which depends on the transition temperature. The variation of $c - a$, the difference in axial lengths of the unit cell, is of the same form, so that there is a simple linear relation between $(c - a)$ and R. From the value of R we may therefore tentatively calculate the axial ratio in any part of the crystal under other conditions.

There is a difference in the birefringent colours of the material enclosed in a double boundary and the adjacent twins. This is possibly due to the fact that c/a is less in these areas, this reduction being the result of the mechanical and electrical stresses around a double boundary, which may also determine its separation.

The orientation of c in the double boundaries is confirmed by the application of an electric field. Then their length and separation increases or decreases as the field is parallel or perpendicular to their c direction. Another transition occurs at − 5° C. The optical behaviour suggests that the tetragonal unit-cell shears in the (001) plane, the new axes being approximately parallel to the [110], [110] and [001] directions of the original cell, the symmetry being orthorhombic. Assuming the relation between $(c - a)$ and R applies approximately in this region, $(c - a)/a$ is reduced by approximately 15 per cent at the transition at − 5° C. and increases slightly at still lower temperatures. Further investigations by X-ray methods are to be undertaken.

The application of electric fields of approximately 2×10^4 volts/cm. to twinned crystals has resulted in complete orientation of the tetragonal axis along the field direction (that is, electric saturation). The field across the crystal itself is very much less, because of the high dielectric constant of barium titanate, together with the air-gap between the crystal and electrodes. This gap is an essential condition, since the crystal expands along the field axis in the process, c being greater than a.

Note added on January 26, 1949. The transition at $\sim -$ 10° C. has been studied by X-ray methods, a shear of 14′ in the $a-c$ plane being observed at $-16°$ C. ($\beta = 89° 46'$). Associated with this change there is an expansion of the a parameter and a slight contraction of c, such that these two parameters become equal, and the polar direction turns through 45° into the [011] or [101] direction. A further transition occurs near $-70°$ C., below which temperature the symmetry appears to be rhombohedral with the polar axis in the former [111] direction.

H. F. Kay
H. J. Wellard
P. Vousden

H. H. Wills Physical Laboratory,
University of Bristol. Oct. 20.

[1] Megaw, *Proc. Roy. Soc.*, A, 189, 261 (1947).
[2] Discussion of Electronics Group of Institute of Physics, *Nature*, 162, 245 (1948).
[3] Hulm, *Nature*, 160, 127 (1947).

A New Application of White-Light Superposition Fringes

White-light superposition fringes have found a number of applications in the past. They are of two kinds—fringes of equal inclination and of equal thickness. Extensive use of the former has been made, first in Brewster fringes, later in the Jamin interferometer; then in 1898 Fabry and Buisson first used multiple-beams, ultimately adopting the fringes for their classical evaluation of the metre. A more recent application has been made by Sears and Barrell in determining the refractive index of air.

Comparable use of white-light superposition fringes of equal *thickness* has not, however, been made; apart from a few experiments described by Fabry in his book "Les Applications des Interférences Lumineuses" (1924), there is little to record. It is the purpose of this note to describe a simple application which reveals qualitative information with high precision.

It has already been demonstrated by interferometry that many varieties of muscovite mica cleave surprisingly true over large areas. A randomly selected sheet of muscovite was silvered on both sides. It was then cut into two with scissors and the two pieces held superposed on each other. The combination was placed in the parallel beam of a standard Fizeau fringe set-up, but with white light. Thus an image of a 'Pointolite' is thrown on to an aperture which is at the principal focus of a lens, and the emergent parallel beam of white light directed at normal incidence on to the mica combination. A lens follows the mica, and the eye is placed at the lens focus. The appearance is striking. Following recognized principles, it is clear that localized white-light superposition fringes of equal thickness will form. If the two pieces of mica consisted of pieces of strictly constant thickness, then the field of view would consist merely of a uniform tint of illumination. But, in fact, there are cleavage steps on mica surfaces and, as is already known, these usually occur in simple multiples of the crystal lattice spacing (20 A.) and may, in fact, be only a single lattice high. It is clear that the superposition principle leads effectively to the production of thin-film interference over path-differences representing the heights of the cleavage steps. The result is that the field of view shows brilliantly coloured areas, each of uniform tint, each being delineated by the boundary of cleavage lines. Thus, in a highly sensitive (but only qualitative) manner, the structure of the mica sheet is revealed. For not only do height changes lead to colour variations, but also inclusions and variations of refractive index have a like effect.

It remains to ask whether this rather restricted new technique has any advantages over the monochromatic multiple-beam method already in use for thin films. The answer is, yes. In two respects the new method is a decided improvement on the old. First, when using monochromatic light, the very sharpness of the fringe distribution is such that cleavage steps may easily be missed if the transmission region corresponds to a thickness well off the intensity maximum; secondly, it can be readily demonstrated by simple calculation that the fringe-width in the combination system is $1/\sqrt{2}$ that in the single system. There is, therefore, a 40 per cent increase in sensitivity.

It is to be emphasized that the interference colours are determined primarily by the individual step-heights and not by the thickness of the mica sheet. With very strict collimation, it should certainly be possible to apply the technique to thick slabs. This being so, equal slabs of optical material can be exactly matched and accurately surfaced, for example, with the dividing plate and compensating plate in a Michelson interferometer, or the plates for a reflexion echelon, etc. Other applications, with both thin and thick interference gaps, come readily to mind.

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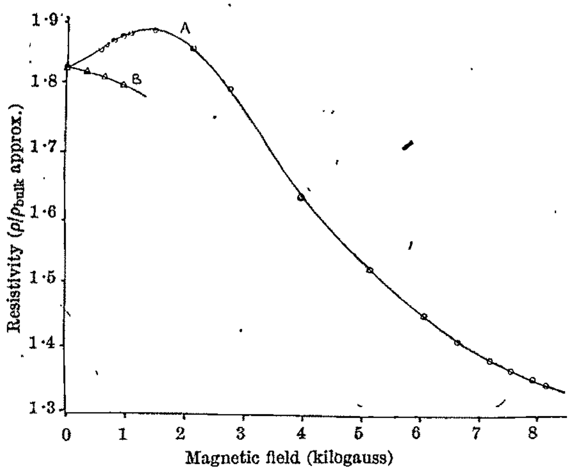
Influence of a Magnetic Field on the Size-Variation of Electrical Conductivity

Miss I. Stone[1], in 1898, appears to have been one of the first to make a study of the anomalous increase in specific resistivity of very thin metal films as compared with specimens in bulk, although the phenomenon was already known. Films of silver as thin as $\sim 1 \times 10^{-6}$ cm. deposited by the 'Rochelle salt process' were used by her. Longden[2] extended this work to evaporated films of platinum, and since that time a considerable amount of work has been carried out on such thin films (for example, bibliography in ref. 3). J. J. Thomson[4] first proposed that the physical limitation of conductor size would produce a shortening of the electron mean free path, with a consequent reduction of effective conductivity, and derived a theoretical expression based on an assumption of a constant mean free path in the bulk metal.

More recently, the accessibility of very low temperatures has enabled the effect to be observed in specimens of considerably larger size ($\sim$ 10–100 μ), with the resulting elimination of a number of subsidiary effects which arise in very thin films. In particular, Andrew[5] has studied wires of pure mercury, and wires and foils of pure tin in the region 1–4° K. One difficulty, emphasized by Andrew, in the interpretation of the data is that of relating the measured conductivity to that of an equivalent bulk sample, since strain and impurity—both productive of high residual resistance at low temperatures—may be expected to play a significant part in finer specimens.

Modern theories of metallic conduction as applied to the phenomenon[6] require an assumption of the degree of 'freeness' of the conduction electrons. It



Variation of resistance with magnetic field: *A*, transverse field; *B*, longitudinal field. (Temp. 4·2° K.)

was therefore considered that an investigation on fine specimens of pure sodium would be worth while, since earlier work on the alkali metals[7] had suggested strongly that the conduction electrons in sodium are almost ideally free. It was also intended in this work to examine the effect in relation to temperature from 20° K. to ~ 4° K., to deduce any variation of the surface reflexion coefficient. Results in this field will be published later; but an interesting effect has been observed when a magnetic field is applied.

The accompanying graph shows the observed variation of electrical resistance in a specimen 30 μ diameter under the application of transverse and longitudinal fields. It is immediately obvious that the effect is essentially of a different character from the customary increase of resistance in a magnetic field (magneto-resistance effect). The remarkable reduction of resistance may be understood if one observes that in a field of ~ 4,000 gauss the conduction electrons in sodium will describe classical orbits of diameter 30 μ. Thus, for example, an electron, having been scattered from one surface of the metal, may have its path so curved by the magnetic field as to avoid subsequent collision with the opposite wall of the specimen and thus have an increased effective path-length. Ultimately, for a sufficiently strong longitudinal field, one would expect that scattering by the walls would become insignificant in comparison with that in the body of the metal. In this case the resistivity should approach a lower limit, namely, that of the metal in bulk. In a transverse field, a similar decrease should occur, although the limiting resistivity will then be greater than that of the bulk material since those electrons travelling more or less parallel to the field will still collide with the walls. With a transverse field, elementary considerations show also that some electrons, dependent on their direction of motion, will suffer an initial diminution of free path which may predominate, although ultimately all free paths should increase. This effect is obvious in the graph, the resistance reaching a maximum around 1,500 gauss for this specimen. On the other hand, one would only expect a progressive increase of free path with a longitudinal field, the electrons pursuing spiral paths around the lines of force. The experimental data confirm this assumption. Measurements on specimens of different sizes under varying fields should provide a knowledge of mean free path and surface scattering coefficient individually: publication of full experimental data and theoretical discussion will follow later.

In conclusion, one may note that this phenomenon is to be distinguished from the diminution of the magneto-resistance effect in very thin films as observed by Patterson[8] and explained by Thomson[4]. In that case, the increased electron-scatter in bulk metal arising from the action of a magnetic field loses its effect as the electron free path becomes curtailed by the physical limits of the specimen.

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Fermi Resonance in Benzene

THE existence of a strong doublet rather than a singlet line in the Raman spectrum of carbon monoxide was explained by Fermi[1] on the theory that when in multi-atomic molecules the frequencies of two independent vibrations are commensurable or nearly so, the vibrations perturb each other, resulting in a mutual repulsion of the two levels and a mixing of eigenfunctions, provided the two vibrations belong to the same symmetry species. Such Fermi resonance is found to occur frequently in many polyatomic molecules, and enables one to explain some characteristic features of Raman and infra-red spectra. For example, it is well known that the Raman spectrum of benzene exhibits two strong lines due to frequencies 1606 cm.$^{-1}$ and 1584 cm.$^{-1}$, whereas only one at 1596 cm.$^{-1}$ is to be expected corresponding to the e_g^+ vibration. The occurrence of this doublet was shown by Wilson[2] to be due to Fermi resonance between 1596 cm.$^{-1}$, which is a pure e_g^+ frequency, and a binary combination 606 cm.$^{-1}$ + 992 cm.$^{-1}$ = 1598 cm.$^{-1}$, the total eigenfunction of which has again the e_g^+ symmetry.

In the course of an analysis of the near ultra-violet emission bands of benzene[3], we have discovered an extended series of such Fermi doublets. The main characteristics of the emission spectrum are represented by progressions of totally symmetric vibrations superposed over one of the e_g^+ vibrations in either state, which circumstance is essential to permit the otherwise forbidden transition. The extended series of Fermi doublets arises in the superposition of one to four quanta of 992 frequency on each of the fundamental doublets, each of which again is loaded with one to four quanta of 160, the difference frequency. The observed data are in agreement with theoretical calculations based on first-order perturbation brought about by the cubic anharmonicity factor in the potential energy function of the molecule.

A detailed account has been submitted for publication elsewhere.

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Oct. 16.

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Low-Level Atmospheric Ducts

In a recent communication in *Nature*[1], McPetrie and Starnecki have directed attention to the presence of atmospheric ducts at or close to the sea surface. The presence of low atmospheric ducts when the air at 100 ft. above sea-level was colder than the sea was found difficult to explain, and it was noted that such ducts were frequently associated with high wind speeds.

In a recent paper[2] of limited circulation dealing with observations in Cardigan Bay, I have shown that the mean specific humidity, s, of the air in the layer between 200 and 2,000 ft. above the sea, after an uninterrupted sea track, is related to the saturation specific humidities at the sea surface temperatures during the previous 48 hours history of the air by an expression of the form

$$s = 0\cdot34\ (s_1 + s_2),$$

where s_1 is the saturation specific humidity at the sea surface temperature at the place of observation, and s_2 that for the sea surface temperature at the place where the air was 48 hours before. Thus the lower the value of s_2 (s_1 varies only slowly with time and is sensibly constant over a period of days at a particular place in Cardigan Bay) the lower the value of s, and hence the greater the value of the humidity lapse in the lowest layers of the air. In the same paper[2], it is suggested that much the greater part of this humidity lapse frequently occurs in the lowest few feet of the air. If the air under examination comes from an area where the sea surface temperatures are much lower than in Cardigan Bay, then the stronger the wind the colder the sea surface temperature at the place the air was 48 hours before, and the greater the value of the humidity lapse in the Cardigan Bay area. The occurrence of low-level radio ducts in conditions of high winds when the air temperature is substantially less than the sea surface temperature can therefore be explained on this basis alone. The occurrence of ducts when the air temperature at 100 ft. was substantially above the sea temperature can almost certainly be explained by the presence of air which had recently come from the warmer and drier land, with the consequent presence of both temperature inversion and humidity lapse in the lowest layers, leading to even stronger ducts than those considered above. It is extremely unlikely that temperature inversions of such magnitude accompanied by a marked humidity lapse could occur over the sea, except in the neighbourhood of a warmer land mass.

I am indebted to the Director of the Meteorological Office for permission to submit this note.

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Nr. Dunstable, Beds.
Nov. 30.

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We are grateful to Mr. Jones for outlining his suggestion as to a possible method for the formation of the low-level atmospheric ducts in Cardigan Bay which we postulate from our radio field-strength measurements. According to current radio-meteorological theory, ducts should not occur during turbulent conditions. It surprised us, therefore, to find from the radio measurements that in the winter high field-strengths, which suggest to us the presence of low-level ducts, could occur even during windy weather. Mr. Jones's hypothesis gives a very satisfactory quantitative explanation of a method by which ducts might be formed during such periods of high wind velocity. High field-strengths during winter, however, appeared to depend more on the fact that the temperature of the air was appreciably lower than that of the sea, rather than on the presence or absence of wind. The main difference between windy and still conditions was not in the amplitude of the received signal but in its stability, remarkably little fading ever being found during windy periods.

Sverdrup, in his book "Oceanography for Meteorologists", arrives at the conclusion that the greatest evaporation occurs when cold air flows over warm water; as in middle and higher latitudes in winter the sea surface is mostly warmer than the air, evaporation should be a maximum in winter and not summer, as generally supposed. Sverdrup's results, while only qualitative, seem to us to account satisfactorily for the possibility of ducts occurring during still air conditions in winter. Sverdrup also concludes that the evaporation should be increased at higher wind velocities because of the presence of spray—a hypothesis which we tentatively suggested in our note to explain the presence of ducts during windy conditions.

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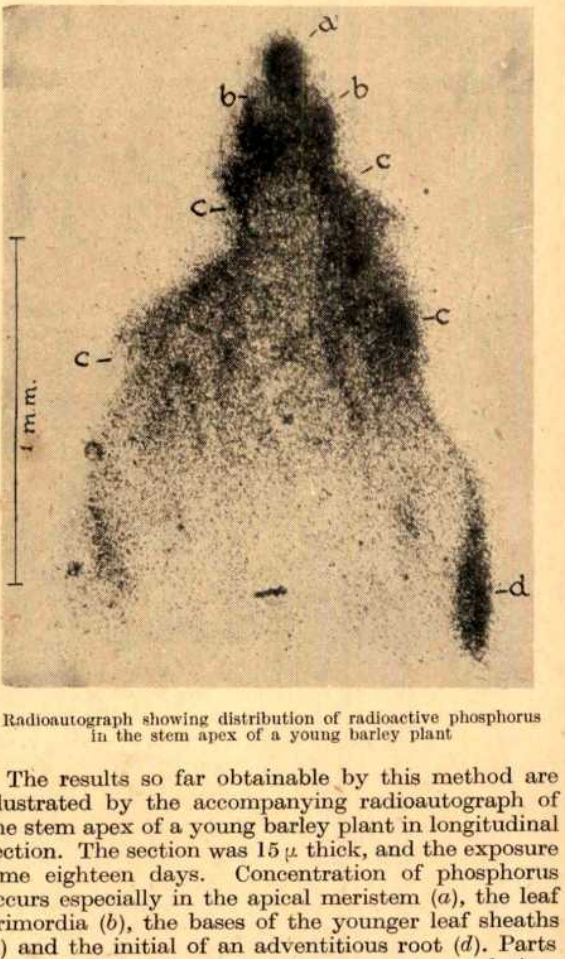
Preparation of Radioautographs to Show the Distribution of Phosphorus-32 in Plant Tissues

Pelc[1] has developed a radioautographic technique to show in microscopic detail the accumulation of iodine-131 in the thyroid gland. A thin 'stripping' photographic emulsion is floated on to the tissue sections mounted on a glass slide. The precision with which the tracer can be located within the tissue depends not only on the thinness of the section and the emulsion but also on the closeness of contact between them. In applying this method to the study of the distribution of phosphorus in plant tissues the following complications arise: (1) a considerable diffusion of phosphorus occurs in the fixatives normally used; (2) the time required to prepare sections by standard plant histological methods is so long that much of the tracer decays before the radioautograph can be exposed.

We have found that these difficulties can be largely overcome by employing a 'freezing substitution' technique which one of us (F. K. S.) is developing for other purposes, and following this by a rapid imbedding method. The time required for preparing sections of material such as cereal root tips has thereby been reduced to twenty-four hours.

The tissue is frozen in *iso*pentane chilled to about − 170° C. and then transferred to absolute alcohol saturated with basic lead acetate, which is maintained at − 70° C. in a jacket of 'dry ice' alcohol. The ice in the tissue *dissolves* slowly in the cold alcohol and the phosphate is precipitated *in situ* as the lead salt. The material thus fixed and largely dehydrated is then imbedded in paraffin wax using tertiary butyl alcohol[2] as a solvent and sectioned in the normal way. Radioautographs are then made by the method of Pelc[1].

Since it is necessary to keep the concentration of tracer below a level at which radiation damage is likely to occur[3], thin fine-grain emulsions such as that described by Berriman[4] and Stevens[5] are usually too slow. A faster Kodak experimental radioautographic stripping emulsion has therefore been used. On account of its thickness, this emulsion gives poorer resolution, but points of accumulation of tracer approximately 15 μ apart can be distinguished one from another.



Radioautograph showing distribution of radioactive phosphorus in the stem apex of a young barley plant

The results so far obtainable by this method are illustrated by the accompanying radioautograph of the stem apex of a young barley plant in longitudinal section. The section was 15 μ thick, and the exposure time eighteen days. Concentration of phosphorus occurs especially in the apical meristem (*a*), the leaf primordia (*b*), the bases of the younger leaf sheaths (*c*) and the initial of an adventitious root (*d*). Parts of the vascular tissue also show some accumulation. For the sake of clarity in reproduction, the radioautograph was removed from the section before it was photographed. The most convenient method for locating the site of accumulation of the tracer is, however, to examine the radioautograph and section in contact. Since it is difficult to stain tissues in contact with emulsions, the phase-contrast microscope is useful for this purpose.

Fuller details of the histological and radioautographic techniques will be published elsewhere.

We are indebted to the Agricultural Research Council for providing a grant in aid of the tracer work the Department of Agriculture; we wish also to thank Dr. S. R. Pelc of the Medical Research Council Radiotherapeutic Unit for much valuable advice, and Dr. R. H. Herz and the Kodak Research Laboratories for the gift of the photographic emulsions.

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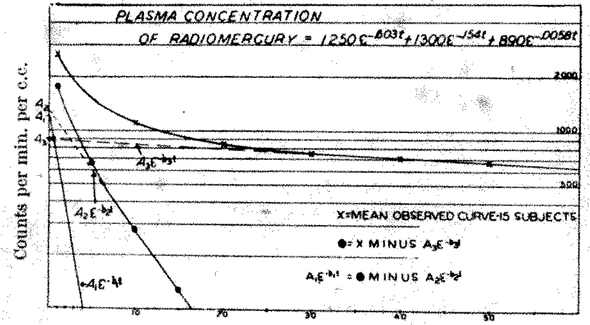
Regression of a Radioactive Mercurial Diuretic from the Plasma of Man

DURING the study of the mechanism of chronic congestive heart failure and other œdematous states, it became more evident that there is need for a better understanding of the pharmacodynamics of mercurial diuretics. Investigations have been carried out with the use of radioactive mercury incorporated in a mercurial diuretic, 'Mercuhydrin' (sodium salt of methoxyoximercuripropylsuccinylurea with theophylline, prepared in this laboratory by Messrs. H. Krahnke, E. Sprengler and D. Kaestner through the courtesy of Dr. H. L. Daiell of Lakeside Laboratories, Milwaukee, Wisconsin, with the use of mercury-203–205 from the A.E.C. Oak Ridge Operations), in order to observe for a period of 100–180 min. the concentration-time course of the isotope in the plasma of man after intravenous injection.

Fifteen subjects were studied. 2 c.c. of labelled mercurial diuretic was injected into the antecubital vein of one arm of the subjects over a period of about 20 sec., and blood samples were drawn rapidly from the antecubital vein of the contralateral side. The interval between collection of blood samples was 4–8 sec. for the first two or three minutes, thereafter increasing as the experiment progressed. After the blood was centrifuged, 0·3 c.c. of serum was placed upon a filter paper disk, allowed to dry and cemented to a metal disk for counting. Measurements of radioactivity were recorded as counts per minute per cubic centimetre of fluid, and were corrected to values corresponding to an injected activity of 10,000,000 counts per minute of radioactive mercury.

The regression-curves observed in all subjects were similar. The accompanying graph, the composite regression curve of all fifteen subjects, is analysed graphically into three exponential rates of regression.

The regression-rates contributing to the concentration-time course of radioactive mercury in the plasma of man are not simple phenomena; rather they are probably the expression of many simultaneously occurring physico-chemical processes. The most rapid regression-rate is brought about largely by mechanical mixing of the tracer in the plasma along with some extremely rapidly occurring biological events. The second regression-rate probably expresses the filling of the potential mercury spaces and the activation of 'potential turnover patterns' for mercury, including diffusion and chemical reactions, which did not actually exist until a relatively



The mean observed plasma concentration-time curve of radiomercury for 15 subjects who received 'Mercuhydrin' intravenously. This curve is analysed graphically into its three exponential regression-rates. The sum of the three individual daughter curves at any time represents the total concentration of radiomercury in the plasma at that time expressed by the general equation,

$$C_p = A_1\varepsilon^{-b_1t} + A_2\varepsilon^{-b_2t} + A_3\varepsilon^{-b_3t}$$

large quantity (78 mgm.) of the element was administered. The third regression-rate is most likely primarily a reflexion of the elimination of the mercury from the body, principally urinary. This is supported by the fact that urinary excretion of radiomercury accounts for practically all this element lost from the plasma after 40 min. or so from the time of injection.

This analysis of the regression of mercury from the plasma of man is undoubtedly an over-simplification of multiple complex phenomena; but it serves as a basis for an understanding of other data dependent upon the concentration of mercury in the plasma. A more detailed discussion of the concentration-time course of radioactive mercury incorporated into a mercurial diuretic will appear elsewhere.

This investigation was aided by grants from the Life Insurance Medical Research Fund, a War Department Grant No. W–49–007–MD–389, and the Mrs. E. J. Caire Fund for Research in Heart Disease. One of us (J. P. M.) holds a National Institute of Health Post-doctorate Research Fellowship.

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Significance of the Enzymic Degradation of Cozymase in Living Organisms

Reason for the existence of a very potent enzyme system degrading cozymase in brain[1] and in certain other cells and tissues[2] has been obscure, as intact cozymase is so important to their normal functioning. The rate of breakdown by ground brain is of the order of 1 μmol./mgm. dry weight/hr.[1], whereas the rate of respiration by the intact tissue is about 0·5 μmol./mgm. dry weight/hr. Brain preparations split the cozymase molecule between the pyridine-N and ribose[1]. The results in Table 1 now show that the degrading enzyme can serve cellular economy in the following ways: (1) By decreasing the quantity of specifically the oxidized form of either coenzymes I or II in coenzyme-dihydrocoenzyme mixtures, their oxidation-reduction potentials can be expected to be lowered, and we have found this to be the case experimentally. (2) This can be expected to affect secondarily the many enzymes sensitive to changes in E_H. (3) The degrading enzyme will compete with dehydrogenases for the oxidized forms of the coenzymes, and in mixtures of dehydrogenases favour the action of those of greatest affinity for the coenzymes. (4) Equilibria at certain dehydrogenases can be expected to be modified by the additional presence of an enzyme which removes one component from the system of four which are typically involved. Thus the formation of β-hydroxybutyric acid would be expected to be favoured in the β-hydroxybutyric–acetoacetate system.

Table 1. Substrate specificity of the enzyme-degrading cozymase

Potential substrate (5×10^{-4} *M*)	Relative rate of degradation
Cozymase	100
Dihydrocozymase	< 0·5
Coenzyme II	65–80
Dihydrocoenzyme II	< 0·5
Cozymase with Dihydrocoenzyme II	90–100

These effects can be expected to influence the course of major reactions in most living systems in which the cozymase-degrading enzyme exists. In agreement with this, considerable changes in carbohydrate metabolism of brain slices have been found[3] to follow inhibition of this reaction by nicotinamide[4], nicotine, 5(4)-3′-pyridylglyoxaline[3] or phenosafranine[5]. The disturbances have included increases (up to ten-fold) in the rates of aerobic or anaerobic glycolysis. Phenosafranine was previously known to inhibit the Pasteur effect in mammalian tissues including brain[5], and some actions of nicotine[6] can be interpreted similarly. The specificity of action of these inhibitors is discussed elsewhere[3]. This evidence for the action of the degrading enzyme in normal tissues implies the existence also of active processes for resynthesis of the coenzymes[7]. The evidence of Judah and Williams-Ashman[8], that linkage between oxidation and phosphorylation in tissue homogenates is inhibited by concentrations of phenosafranine comparable with those of the present experiments, suggests that the degrading enzyme functions in aerobic phosphorylation. Its inhibition, leaving more inorganic phosphate and cozymase available for glycolysis than would otherwise be the case, would thus disturb the Pasteur effect.

Effects of the enzyme from the central nervous system on redox potentials can be very easily demonstrated by experiments of the type illustrated in Table 2. In this, dihydrocozymase to 10^{-4} *M* was added in Thunberg tubes to solutions containing the dyes of Table 2 in phosphate, *p*H 6·5, with a 1/30 dilution of a heart extract[9]; half the tubes contained a preparation of the cozymase-degrading enzyme from beef spinal cord (1·2 mgm. dry weight/tube, capable of degrading 3 μmol. cozymase/hr.). The enzyme had no effect on reduction of the positive methylene blue, but caused much greater reduction of the two negative dyes.

Table 2. Effects of cozymase-degrading enzyme on the degree of reduction of dyes by dihydrocozymase

Dyes	Percentage reduced	
	without enzyme	with enzyme
Methylene blue	>97	>97
Neutral red	20	86
Benzyl viologen	< 3	8

It is also interesting to observe that an enzyme which inactivates dihydrocozymase at a greater speed than cozymase has been observed in certain tissues, including intestinal mucosa[10]. This enzyme can be expected, by arguments similar to those advanced above, to raise redox potential. The coenzyme-degrading system in mammalian nervous tissue is associated with structures insoluble in physiological salt solutions[11] and can be expected to cause local differences in the concentrations of the coenzymes. It will be observed that several other enzymes exist which rapidly degrade other constituents[12] very important in normal cell economy, and that these can similarly be regarded as controlling group potentials[13]. In particular, adenosine triphosphatase shows many analogies with the cozymase-degrading system, and the two are, indeed, likely to have interrelated effects[14]. The possible connexions of these with the specific functions of nervous tissues are discussed elsewhere[15].

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March 10.

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*l-nor*Adrenaline in the Suprarenal Medulla

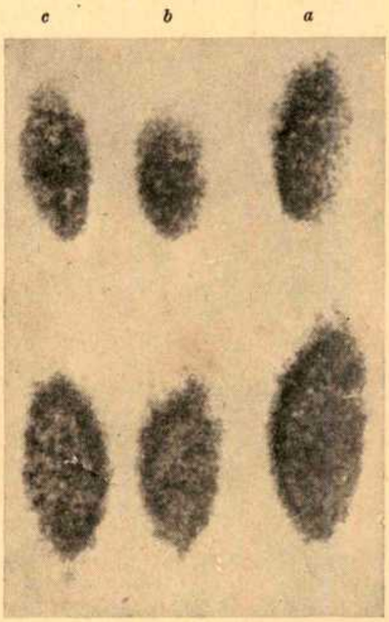
THE demonstration that *nor*adrenaline constitutes the specific neurohormone of adrenergic nerve fibres (sympathin N)[1] has directed attention to the occurrence of this substance in biological material. A recent contribution in this field is the report by Pamela Holton[2] that adrenal medullary tumours contain a high proportion of *nor*adrenaline. Normal suprarenal glands also contain *nor*adrenaline, as shown by Holtz[3]. The present report confirms these findings with the use of different techniques.

Suprarenal glands from cattle were extracted with 5 per cent trichloracetic acid and the acid removed with ether. The extracts were tested for the presence of *nor*adrenaline biologically by the blood pressure of the cat before and after 933 *F* and by using paper chromatography[4]. Quantitative determinations of *nor*adrenaline and adrenaline were made according to the method of Euler and Hamberg[5]. The latter method depends on the different *p*H-optima for the formation of adrenochrome and *nor*adrenochrome with iodine. At *p*H 4 and an oxidation time of 1½ min., the formation of adrenochrome is complete, whereas only approximately 7 per cent of the *nor*adrenaline is oxidized. At *p*H 6 an oxidation time of 3 min. gives the sum of adrenochrome and *nor*adrenochrome.

Extract	*nor*Adrenaline–HCl (μgm./mgm. fresh tissue)	Adrenaline–HCl (μgm./mgm. fresh tissue)
1. 49 gm. whole glands	0·68	1·80
2. 70 gm. ,, ,,	0·70	1·98
3. 500 gm. ,, ,,	0·48	2·16
4. 6·0 gm. medulla	2·68	11·3

The colorimetric method would not differentiate between *dl*- and *l-nor*adrenaline. The activity was therefore tested on the blood pressure of the cat and compared with adrenaline and *l-nor*adrenaline. Extract 2 was equivalent to 2·0 μgm. *l-nor*adrenaline per mgm., or 3·2 μgm. adrenaline per mgm. (ratio 1·6 : 1). The figures found colorimetrically would give $\frac{1\cdot98}{1\cdot6} + 0\cdot70 = 1\cdot94$ μgm. *l-nor*adrenaline activity on the blood pressure per mgm., which compares well with that actually found. After treatment of the cat with 933 *F*, which reversed the action of adrenaline but not that of *nor*adrenaline, a mixture of 2 μgm. adrenaline and 0·7 μgm. *l-nor*adrenaline gave the same picture as 1 mgm. extract and differed markedly from the effect of 3·2 μgm. adrenaline. Extracts 3 and 4 yielded similar results.

Paper chromatography with *n*-butanol saturated with *N* hydrochloric acid as solvent gave a close correspondence between the migration of a suprarenal gland extract purified by adsorption to alumina and a mixture of *nor*adrenaline and adrenaline (see accompanying illustration).



Paper chromatogram with acidulated *n*-butanol as solvent. (*c*) Mixture of *nor*adrenaline and adrenaline in proportion 1 + 2. (*b*) Extract of suprarenal gland purified by adsorption on alumina. (*a*) Mixture of *b* and *c*. •Upper set of spots represents *nor*adrenaline, lower set adrenaline

The presence of a sympathomimetic compound in suprarenal extracts with stronger blood-pressure action than adrenaline, such as *l-nor*adrenaline, is also indicated by the earlier results of Schild[6].

The present results show that the normal suprarenal gland from cattle contains *l-nor*adrenaline in appreciable amounts, as previously shown for adrenergic nerves. The results support Blaschko's concept of adrenaline formation in the chromaffine cells[7].

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Proteolytic Activity in Eggs and Sperms from Sea-Urchins

In studying the influence of water extracts from fertilized *Arbacia lixula* eggs upon unfertilized eggs, J. Runnström found that the jelly coat was attacked by the extract (unpublished). In order to examine this activity, extracts were prepared from fertilized and unfertilized eggs and also from sperm. The material was collected at the Zoological Station, Naples, in the spring of 1948, and the investigations started there and continued in Stockholm.

The material was lyophilized and the extractions carried out in the cold for six hours; afterwards it was dialysed for 24 hours against sea water. The activity was tested on gelatin and the effect measured in Ostwald viscosimeters at 35·5° C. The buffer capacity of gelatin was sufficient to maintain the *p*H during the experiment. The samples were made up of 1·00 ml. extract and 3·00 ml. of 4·0 per cent gelatin (Fisher Sc. granular, containing 0·005 per cent merthiolate), as sterilizing agent.

Extracts from eggs. As shown in Fig. 1, there is some proteolytic activity in the unfertilized egg; but three minutes after fertilization the activity is stronger than in unfertilized eggs. Thus it can be assumed that after fertilization there is liberated in the egg a proteolytic enzyme (or complex of enzymes) taking part in the processes occurring after fertilization; but after a brief time the activity of the enzyme is abolished. The activity exhibited by extracts from unfertilized eggs is perhaps due to activation during the freezing or the extraction.

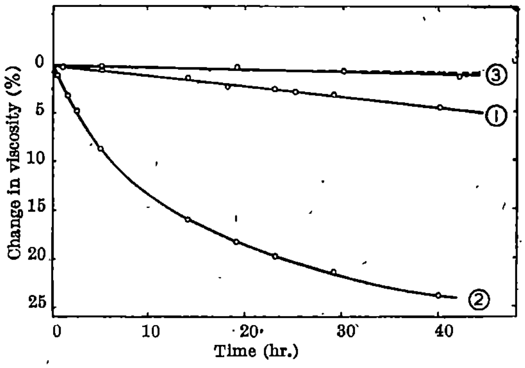

Fig. 1. Activity of egg extracts (*Paracentrotus*). (1) Unfertilized eggs. (2) Three minutes after fertilization. (3) Thirty minutes after fertilization. Control (extract 1 boiled 30 min.): dashed line. Initial concentration of dry matter 1·8 per cent. Temp. 35·5° C. *p*H 6·25

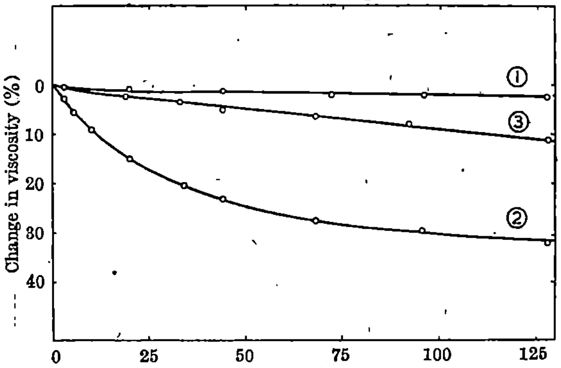

Fig. 2. Activity of sperm extracts. (1) *Arbacia* control (extract boiled 30 min.). (2) *Arbacia* extract. (3) *Paracentrotus* extract. Initial concentration of dry matter 5·0 per cent. Temp. 35·5° C. *p*H 6·45

Extract from sperms. Fig. 2 shows the activity of two different sperm extracts, one from *Arbacia*, another from *Paracentrotus lividus*. The former is more active than the latter. It is not yet established whether this depends upon a lower concentration of the enzyme, or on a lower rate of extraction in the *Paracentrotus* sperm.

A full report of this work will appear elsewhere. I wish to express my gratitude to Prof. J. Runnström for suggesting the subject.

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Effect of Humidities and Temperatures on the Size and Number of Oocysts of *Plasmodium gallinaceum* Transmitted by a Mosquito

Mosquitoes need a certain amount of moisture in the atmosphere in which they live. From the investigations of earlier workers[1], we find that changes in the humidity influence the longevity of the insect host and consequently that of the parasite within; low, as well as very high, humidities are detrimental. But if a mosquito is infected with the malaria parasite (*Plasmodium*), the size of the oocysts is not influenced by atmospheric humidity. As to the number of oocysts, according to Gill's work, this is not influenced either. In the work done here, *Aedes ægypti* were fed on chicks infected with *Plasmodium gallinaceum*, and the speed and degree of development of oocysts in the mosquito under various climatic conditions were studied.

Method and technique. In these experiments the mosquito was looked upon solely as the medium in which the parasite grows. Jars containing sulphuric acid and water in various proportions were used to obtain varying degrees of relative humidity. In a preliminary experiment, mosquitoes just fed on a chick were put in celluloid cylinders covered with netting inside the jars. At temperatures of 18° and 25° C., and relative humidities of 50, 60 and 70 per cent, most mosquitoes lived five or more days; this is long enough to allow oocyst development. At either 30 or 90 per cent relative humidity the mosquitoes died in a short period.

In a second series of experiments, a highly infective chick was chosen, and offered to the mosquitoes in their cages. Twenty engorged mosquitoes were then placed in cylinders inside the jars. One jar at each humidity was incubated at 25° C., and another set of three jars in the laboratory at ± 18° C. On the sixth day after the meal the numbers alive were as follows:

	18° C.			25° C.		
Relative humidity	50	60	70	50	60	70
Mosquitoes	12	17	15	13	16	14
Oocysts, mean	10·92	28·76	28·80	11·00	33·25	32·06

These were dissected, the number of oocysts and their size measured in each individual mosquito. The results are shown in the bottom line of the table.

As regards the size of these oocysts, they did not seem to vary much, though those kept at 18° C. were on the average smaller than those at 25° C. Measurements ranged between 15·8 and 17·6 μ at 18° C., and between 18·5 and 20·2 μ at 25° C.

Discussion. Humidity does not affect the speed of development of oocysts (which is affected by temperature); but it clearly affects the number of oocysts which develop, a low humidity being associated with a smaller number of parasites.

One might perhaps think that a low humidity would kill the most heavily infected mosquitoes, because the plasmodial infections might have injured them. But this explanation is ruled out, for the figures do *not* demonstrate a particularly high mortality at the lowest humidity which I used (50 per cent). One is left to suppose that at the lower humidity the increased evaporation from the insect must have altered the blood or tissues of the mosquitoes and had an unfavourable effect on the development of the parasite. It should be stressed, however, that conditions in this experiment differ from those met with in Nature, where the mosquito might be able to get access to drinking water however low the relative humidity of the environment might be. In this sense the results are only of academic interest and should not be applied to natural conditions.

The effect of temperature in my experiments only shows that at high temperatures (25° C.) the rate of growth of oocysts is faster than at lower temperatures (18° C.). The size of oocysts at 25° C. is always larger, although both batches of mosquitoes were fed on the same bird on the same day.

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Analysis of Heteroploidy Produced by Chloracetophenone

THE problem of demonstrating and analysing the degree of ploidy of non-dividing cells is continually arising in different contexts, for example, in cancers, or giant cells in tissue culture. Chromosome counts may not be available in such material, and recourse must be had to indirect methods such as those reviewed by Fankhauser and Humphrey[1], including measurement of cell and nuclear volume, nuclear spacing, projected areas of uncountable mitotic figures, counts of heterochromatic spots and maximum number of nucleoli. Huskins demonstrated polyploidy in non-mitotic plant cells by inducing them to divide with 3-indole acetic acid and counting chromosomes. None of these methods except Huskins's[2] are entirely independent of prior study in the same material of tissues of known degrees of ploidy, and one of the most reliable methods (maximum number of nucleoli) breaks down when applied to limited material or to mixed tissues of varying ploidy. The interesting paper of Biesele, Poyner and Painter[3] utilizes and reviews indirect methods in respect of polyploidy and the related condition of polyteny in mouse cancers, but on plentiful material and with the assistance of chromosome counts.

The necessity of finding a reliable indirect method was encountered while examining tail-tip preparations of *Rana temporaria* tadpoles which had been subjected at the gastrula stage to $5 \times 10^{-6} M$ chloracetophenone. In untreated tadpoles, the nuclei of pigmented and unpigmented epidermal cells are thin disks of equal mean projected area. In treated tadpoles the unpigmented cells are unaffected: the pigmented cells and nuclei, however, although normally differentiated, were giant and non-mitotic, and some cells were polynucleate. For various reasons the indirect methods referred to above were all impracticable or inconclusive; at least pentaploidy was indicated (maximum number of nucleoli five), and cell and nuclear size suggested a degree of heteroploidy between tetra- and octoploid.

It was found that a much more precise analysis of ploidy could be effected by an empirical approach involving consideration of the numbers of nucleoli and their projected areas as measured on *camera lucida* drawings. Six types of nucleus were examined

Table of mean nucleolar areas in epidermal cells of *Rana* tadpoles. Projected areas of nucleoli measured in cm.^{2} under linear magnification 1,780. For each mean a preliminary analysis (where relevant) gave no significant differences within nuclei. Age counted from day of treatment (gastrulation)

Group	Type of cell	Number of nucleoli per nucleus	Mean area per nucleolus ± S.E. of mean: number of nucleoli measured in brackets. Age of tadpoles:		Combined mean nucleolar area (unweighted)
			4-day	8-day	
I	Diploid	2	0·123 ± 0·021 (16)	0·109 ± 0·006 (14)	0·11
	Giant	4	0·101 ± 0·007 (16)	0·111 ± 0·007 (12)	
II	Giant	3	0·146 ± 0·011 (18)	0·136 ± 0·008 (9)	0·14
III	Diploid	1	0·240 ± 0·025 (8)	0·220 ± 0·031 (7)	0·22
	Giant	2	0·180 ± 0·017 (16)	0·245 ± 0·022 (16)	
IV	Giant	1	0·355 ± 0·030 (4)	0·464 ± 0·025 (10)	0·41

in uninucleate cells, namely, normal diploid (unpigmented) cells with either one large or two small nucleoli per nucleus, and giant (pigmented) cells with one, two, three or four nucleoli per nucleus. The mean areas of the nucleoli in each type of nucleus were determined in two tadpoles of different age, as shown in the table. *t*-Tests show that the data for each tadpole fall into four groups; means in any one group differ from means in other groups; means within a group do not differ. The only exception among the various comparisons is that Group II in the 4-day tadpole does not quite attain a significant level of difference from the highest member of Group I and the lowest of Group III.

As well as falling into groups, the data also indicate a simple and striking proportion between nucleolar areas. The total nucleolar area (that is, the product of mean nucleolar area and number of nucleoli per nucleus) is uniformly about twice as great in giant nuclei as in diploid nuclei. These results can only be explained by a condition of tetraploidy in the giant cells. The combined areas in the last column for Groups I, II, III, IV are close to the 1 : 1⅓ : 2 : 4 proportion, which would be expected in such circumstances.

One of the only two 5-nucleolate nuclei was present in one of these tadpoles: the nucleoli approximated closely to two of Group I size and three of Group III size, indicating, therefore, octoploidy.

In the light of these results, cell and nuclear areas which had been measured in these and sixteen other tadpoles could now be interpreted; the mean areas were much the same in all tadpoles, and the effect of chloracetophenone was therefore of general occurrence. In addition, some analysis of polynucleate cells could be made; for example, cells with two tetraploid nuclei were found, and the occasional presence of small non-nucleolate nuclei indicated the occurrence of aneuploidy.

It is thus possible to state with some certainty that chloracetophenone applied to frog gastrulæ gives rise in the tadpole to epidermal cells which are mainly tetraploid, together with some octoploidy, aneuploidy, and combined heteroploidy and polynuclearity. This is interpreted as evidence of interference with the spindle mechanism.

As the method of determining ploidy is purely empirical, based on differences and identities in the data, it may well prove of some general use. The fact that a simple proportion existed between total nucleolar area in a nucleus and the degree of ploidy was a fortunate accident which simplified the interpretation; but the demonstration of tetraploidy in Groups I and III at least would be unaffected by a more complicated proportion such as might occur in other material.

Chloracetophenone is known to be a specific inhibitor of all enzymes the action of which depends on —SH groups[4]; the bearing of this on the production of heteroploidy and other effects in Amphibia is at present under investigation.

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Cytoplasmic Bud Formation in Hymenopteran Spermatogenesis

Many early workers on hymenopteran parthenogenesis describe the formation of a cytoplasmic bud and its pinching off during the first spermatocyte abortive division. Earlier observations were tabulated by Sanderson[1], to which may now be added the following:

Group	Species	Abortive division	Authority
Braconidæ	*Habrobracon juglandis*	Bud pinched off	Torvik-Greb[2]
Cynipidæ	*Neuroterus baccarum*	No bud pinched off	Dodds[3]
Ichneumonidæ	*Acnoplex smithii*	Bud pinched off	Koonz[4]
Ichneumonidæ	*Spilocryptus extrematus*	Bud pinched off	Koonz[5]
Tenthredinidæ	*Diprion polytomum*	No bud pinched off	Smith[6]
Sphecoidea	4 species	No first division	Whiting[7]

The phenomena have often been discussed from an evolutionary point of view, White[8] expressing the situation thus: "The functional significance of these cytoplasmic phenomena is far from clear. The bees are morphologically the most 'highly evolved' group of the Hymenoptera but they have preserved a remnant of the first meiotic division that has been lost in the far more primitive sawflies. Yet when we come to the second meiotic division the bees seem to have acquired a specialized mechanism whereby the cytoplasm is unequally distributed to the two spermatids one of which is functionless."

In sawflies (Tenthredinidæ) Sanderson[1] was unable, despite repeated search, to be satisfied that such cytoplasmic buds were freed, stating: "Appearances would indicate that cytoplasmic buds are freed, but closer examination reveals that these bodies are merely sections through the cytoplasmic bridges by which the spermatocytes are bound together, the 'Zellkoppelungen' and 'Interzonal bodies' of German and American authors respectively."

The seeming anomalies in Hymenoptera therefore led me to devote great attention to these buds during studies on spermatogenesis in the sawfly *Pteronidea ribesii*. In sections it is extremely difficult, if not impossible, to say with certainty whether the 'buds' are sections of bridges or not. With mounts of fresh material, however, this doubt can be resolved, for one of the most striking appearances in a mount of testis at the maturation stage is the number of free anucleated cytoplasmic buds. Examination of unruptured cysts clearly shows that these buds are

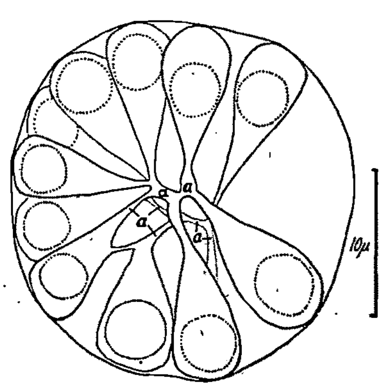

Fig. 1. Cyst of pear-shaped first spermatocytes at interkinetic stage. *a*—Cytoplasmic bridges

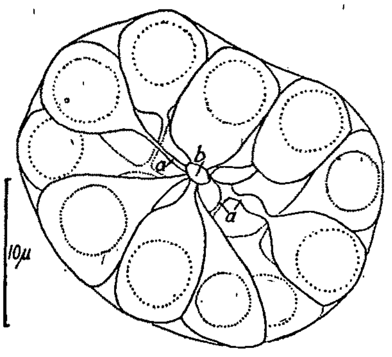

Fig. 2. Cyst of first spermatocytes about prophase stage. *a*—Cytoplasmic bridges, *b*—adherent bud

present in large numbers in cysts of spermatids but are few at the anaphase and metaphase of the second division and, except in a few cysts, are not found before this division.

Whether a bud is freed or not at the end of the abortive (first) division can in my opinion be satisfactorily interpreted for *Pteronidea ribesii* as follows.

The first spermatocytes are roughly pear-shaped and have their apices directed toward the centre of the cyst, the cells being connected by cytoplasmic bridges containing the 'interzonal' or 'cell-coupling bodies' (Fig. 1). At prophase and metaphase the cell shape is more rounded, or even spherical if space allows, and the cytoplasmic bridges appear as in Fig. 2. It would seem that the substance of the 'interzonal body' is more viscous than the cytoplasm of the cell body, so that the rounding of the cells causes the bridges to become more attenuated, some occasionally breaking and causing the formation of buds attached to the cells and containing the 'interzonal body' substance. The axis of the abortive spindle is usually radial, and at telophase there is a slight elongation of the cells along this axis so that they once more become predominantly pear-shaped (Fig. 3). The changes indicated in Fig. 4, *a–d*, have been observed when a cell with a cytoplasmic bud once more is connected with other cells, re-forming cytoplasmic bridges at the telophase of the abortive division. The telophase chromosome clump resolves itself into the chromosomes of the second metaphase plate, and the cell once more rounds itself as far as space in the cyst allows. This rounding is far more pronounced than in the first division, and therefore causes the rupture of more cytoplasmic bridges and the consequent appearance of quite a number of cells at the metaphase stage with cytoplasmic buds (Fig. 5) adherent. The axis of the second division is at right angles to the first division spindle, and therefore at approximately right angles to the cytoplasmic bridge process or bud. The elongation of the cells at anaphase and their subsequent cleavage into spermatids result in the separation of some of these cytoplasmic buds or in spermatids with buds adherent (Fig. 6).

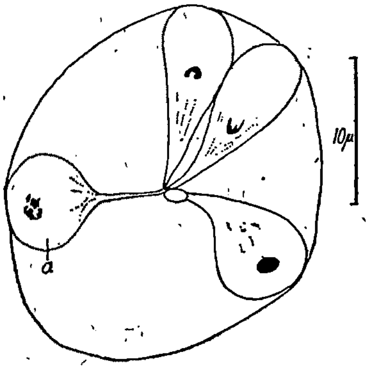

Fig. 3. Cyst showing three cells at abortive telophase stage and cell '*a*' more advanced and entering second metaphase stage

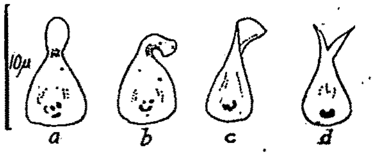

Fig. 4. Successive stages of a cell from anaphase, *a*, to telophase, *d*, of abortive division, showing cytoplasmic bud in *a* eventually bifurcating in *d* to reform cytoplasmic bridges with two other cells

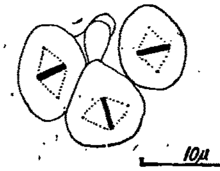

Fig. 5

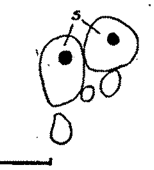

Fig. 6

Fig. 5. Cells at metaphase of second division, two with buds

Fig. 6. Free buds from cyst of spermatids, two shown adhering to spermatids, *s*

Meves and Duesberg[9], regarding *Vespa crabro*, in opposition to Mark and Copeland (who find the buds to be freed at the beginning of metaphase), state that they find the buds attached to the mother cell at anaphase of the second division. From Meves and Duesberg's description and drawings, and from Meves's[10] observations on the honey-bee, I conclude that the above interpretation might also explain their findings.

The formation of cytoplasmic buds, freed or not, during maturation divisions, at least in the sawfly *Pteronidea ribesii* if not in other and more highly evolved Hymenoptera, can, I think, be more satisfactorily interpreted as the result of the 'sticky' property of the cell coupling (interzonal) body interfering with the mechanics of cell division during the rounding of the cell at metaphase, and has not the evolutionary significance commonly attributed to it, namely, that it is a remnant of cytokinesis.

I wish to thank Prof. A. D. Peacock and Dr. Ann R. Sanderson, University College, Dundee, for their active interest in my work; Prof. C. M. Yonge, University of Glasgow, for laboratory accommodation; and the Carnegie Trust for financial assistance.

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Identity of the Shell Pigment of *Haliotis cracherodii* Leach

In 1903 Schultz directed attention to the blue, acid-soluble pigment which occurs in the shells of the Californian abalone. Subsequent studies by Schultz, Schultz and Becker[1], Kodzuka[2] and Lemberg[3] have further subdivided the pigments present; but there has been no agreement as to their identity. Schultz, in his later papers, pointed to the similarity between the visible absorption band of the main pigment ($\lambda_{\max.}$ 622 mμ) and that of the known indigos, and Lemberg identified the pigment provisionally as a pyrrole body, since its solubility in dilute acids is greater than that of most indigoids. The pigment is known to give a strong colour reaction with nitrites and with fuming nitric acid. There has been doubt about the exact nature of this reaction, and about the number of pigments responsible for it.

Using a technique of chromatography on talc, and starting with acid extracts (in 2*N* hydrochloric acid) of shells of *Haliotis cracherodii*, of which Schultz's *H. californiensis* is a variety, we have obtained clear-cut separation of the pigments on the column into a lower green, brown and violet series, some of which give reactions typical of bilitrienes, and a main blue fraction corresponding to Lemberg's pigment *B*. We further purified this main pigment by chromatography of amyl alcohol extractives from the original acid solution, and produced a homogeneous fraction which could not be resolved on the column. Details of this preparation will be published elsewhere.

The reaction of the blue pigment with nitrite is not typical of Gmelin's bilitriene reaction; it is, however, closely similar to that given by indolylacetic acids (Nencki–Sieber test), and the amyl alcohol-soluble product of the reaction gives a visible absorption, plotted on the Beckmann spectrophotometer, which resembles that recorded for the urorosein pigments by Homer[4], by Watson[5], and by Rimington, Holiday and Jope[6].

Haliotis derivative		Urorosein (Watson[5])
Ammonium hydroxide:	522–492	555–557 mμ
Hydrochloric acid:	559–550, 540–490	544, 511

Urorosein from indolylacetic acid (Homer[4])
552–531, 505–492
from indolylaceturic acid
579–539, 502–485

In view of these findings, a specimen of the blue pigment in chloroform–cyclohexane was examined for fine structure in the ultra-violet region, using a Hilger medium quartz spectrograph and a hydrogen arc source, and the resulting bands compared with those of indigotin. The following results were obtained:

	Haliotis blue	Indigotin
Bands $\lambda_{\max.}$ (A.)	3570	3560
	3370	3370
	3226	321
	3070	3070
	—	2856
	—	2745

These results confirm the view of Schultz and Becker[1] that the pigment is closely related to indigotin, and is not a pyrrole; in its solubilities it differs considerably from the known[3] indigos, being considerably more soluble in aqueous acids even than the N—N′ dialkyl indigos. Details of its behaviour, and of the concomitant pigments, will appear elsewhere.

The finding is of interest in view of the occurrence of substituted indigos in the eggs and hypobranchial gland of many Stenoglossa. Pigments of this type have not previously been detected in the lower gastropods.

Acknowledgment is due to Prof. C. Rimington for his kindness in providing access to the Beckmann spectrophotometer, and to E. M. Jope, of the London Hospital Spectrographic Department, for examining and reporting on the ultra-violet spectrum of the substance.

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[3] Lemberg, R., *Hoppe-Seyler's Z. phys. Chem.*, **200**, 173 (1931). Nencki, M., and Sieber, N., *J. prakt. Chem.*, **26**, 333 (1882).

[4] Homer, A., *J. Biol. Chem.*, **22**, 345 (1915).

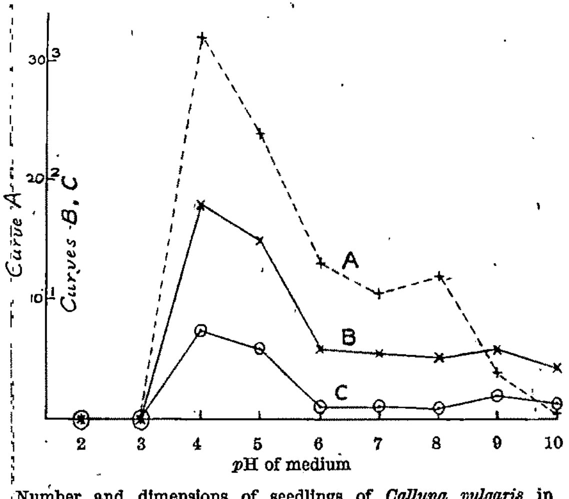
[5] Watson, C. J., *Proc. Soc. Exp. Biol. N.Y.*, **39**, 514 (1938); **41**, 591 (1939).

[6] Rimington, C., Holiday, E. R., and Jope, E. M., *Biochem. J.*, **40**, 669 (1946).

Germination and Development of Heather and the Hydrogen Ion Concentration of the Medium

Several workers[1-3] have shown that, in the field, heather (*Calluna vulgaris* Salisb.) is found most frequently and attains its maximum development on soils the reactions of which are about *p*H 4. I have examined the germination and the subsequent seedling development of *Calluna* seeds planted on agar media adjusted to give a range of reactions. A quantity of 1 per cent British agar was prepared with a form of Knop's solution. This was divided equally between nine flasks. The contents of these were adjusted to *p*H 2, 3, 4, 5, 6, 7, 8, 9 and 10, respectively, by the addition of the requisite quantities of sulphuric acid or caustic soda. After adjustment, the agar in each flask was poured into six 1-in. boiling tubes to give a depth of agar of about 1½ in. The tubes were plugged and the agar allowed to set. A liberal sowing of *Calluna* seeds was then made in all tubes.

After six weeks, germination was found to have occurred in all the cultures, although, in most cases,



Number and dimensions of seedlings of *Calluna vulgaris* in relation to *p*H. (*A*) Mean number of seedlings; (*B*) average of mean shoot-lengths (cm.); (*C*) average of mean root-lengths (cm.)

it had not proceeded beyond the stage of emergence of the radicle. Seven months after sowing, the seedlings in each tube were counted; also, the lengths of roots and shoots were measured. The means of these data for the six tubes at each reaction are plotted against pH in the accompanying graph. The bimodal form of curve A is clear, and a tendency to the same is perceptible in curves B and C. Others have observed this phenomenon in studies of the relations of various species to hydrogen ion concentration.

This experiment, which was performed in the Botany Department at the West of Scotland Agricultural College, confirms the field evidence that the optimal reaction for *Calluna* is in the region of pH 4. Above this level, not only do the germination of seeds and the growth of seedlings decline, but also chlorosis is progressively more marked. Even at pH 5, severe chlorosis of the tips occurred. Local rises in soil reaction might thus account for the frequent appearance of chlorotic heather plants in the field.

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Oct. 28.

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[3] Olsen, C., *C.R. Carlsberg Lab.*, **15** (1923).

Occurrence of a Species of *Clymenella* Verrill (Polychæta, fam. Maldanidæ) on the North Kent Coast

McIntosh[1] states that "the representatives of the Maldanidæ are met with but seldom in British waters, and in the majority of instances only fragments are secured". In fact, a study of the literature reveals that many species, and even genera, are described from preserved material, often in a fragmentary condition. It is of interest to record, therefore, that a fairly large maldanid is moderately common in the intertidal zone at Whitstable near the ordinary low-tide mark.

The worm belongs to the genus *Clymenella* Verrill, and this is, so far as I can find out, the first record of a member of this genus occurring on the coasts of Britain, or, for that matter, on the coasts of Europe. Fauvel[2], it is true, describes a *Clymenella* (?) *cincta* from Manche (Dinard), but notes that "Cette espèce n'étant connue par un seul fragment antérieur de 12 sétigères, il n'est pas possible, vu l'absence de la région postérieure, de préciser exactement à quel genre elle appartient".

Monro[3], in discussing the genus *Clymenella*, points out that there are two groups of species included in that genus, "the *torquata, rubrocincta, somersi* and (?) *elongata* group, with anterior *uncini* differing little, if at all, from their normal *uncini*, and the *minor, cincta* south-west Australian and Indian Ocean *Clymenella* sp. group, with anterior ventral *acicular hooks*".

The maldanid found at Whitstable clearly belongs to the *torquata* group and more closely resembles *Cl. torquata* than any other species. It may prove to be a new species; but this cannot be decided until a comparison has been made with specimens of *torquata* obtained from America. *Clymenella torquata* and its allied species are reported solely (?) from the coasts of North America, and it is possible that the Whitstable maldanid may prove to be a recent immigrant comparable in this respect with *Urosalpinx cinerea* and *Crepidula fornicata*.

A description of the worm is in course of preparation.

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London, E.1.
Oct. 29.

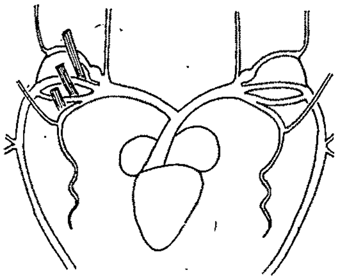
[1] McIntosh, W. C., "A Monograph of the British Annelids. Polychæta"; 3. "Opheliidæ to Ammocharidæ" (Ray Society, London, 1915).

[2] Fauvel, P., "Polychètes Sédentaires", Faune de France, **16** (Paris); pp. 182–83 (1927).

[3] Monro, C. C. A., "Polychæta", John Murray Expedition, 1933–34, Scientific Reports, **4**, No. 8 (1937); see p. 310.

Persistent Fifth Arterial Arch in the Frog

A RARE abnormality in the arterial system of the common frog was found in a male specimen from Cornwall. The fifth aortic arch persisted on both sides of the animal and was patent. Carotid, systemic and pulmo-cutaneous arches were normal; but the fifth arch branched off from the pulmo-cutaneous. It joined the systemic arch laterally and was large and open. Right and left sides were symmetrical. A ligamentum aortico-carotideum was present. The relation of the posterior petro-hyoideus muscles was as follows. The internal carotid artery slipped beneath, that is, dorsal to, the first petro-hyoid muscle, the systemic arch dorsal to the second, and the abnormally persistent arch dorsal to the third, thus preserving the regularity of arrangement which is lost when the fifth arch disappears during development.



Rana temporaria. Male. Heart and arterial arches. The left carotid, systemic, persistent fifth and pulmo-cutaneous arches are shown, with the ligament connecting the internal carotid artery and the systemic arch. The right arches are similar, and the first, second and third posterior petro-hyoid muscles have been drawn in position

So far as I am aware the abnormality described has not been recorded on *both* sides of an adult frog. O'Donoghue[1] gave an account of a persistent fifth arch on the left side of a male, without reference to the musculature, and in his specimen a true ductus caroticus was present.

Abnormalities in the venous system are much more common, and among this group of a hundred frogs three exhibited persistent lateral abdominal or posterior cardinal veins.

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March 7.

[1] *Anat. Anz.*, **75**, No. 21/22 (1933).

A NEW TYPE OF BETATRON WITHOUT AN IRON YOKE

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BY far the most expensive and the heaviest part of betatrons, as usually constructed, is the iron yoke with its complicated pole-pieces. We propose to describe a mode of construction which uses no yoke, and which, though restricted in its applications, offers several important advantages over the original type of betatron.

The main features of our betatron are two coils in series, with a sealed-off glass acceleration tube between them. The dimensions are chosen so as to fulfil the well-known condition $0 < n < 1$, n being determined by the radial decrease of the magnetic field, which is assumed to be proportional to r^{-n}. The flux required within the electron orbit is attained by means of a small iron core placed in the axis of the coils. This iron core is inserted inside the 'Pertinax' tube, visible in the photograph. Saturation of this core effects contraction of the orbits towards the end of an acceleration period, until the electrons strike a tungsten target 0·1 mm. thick. The core, made of transformer sheet-iron, is interrupted half-way by a small gap which is so adjusted that the contribution of its stray field makes $n = \frac{1}{2}$ over almost the entire area of the electron orbits.

The dimensions of the tube are hence not restricted by pole pieces, and have been made very large. The inner wall of the tube is covered with a transparent, fluorescent semi-conductor, which has proved valuable for investigating the behaviour of the electron beam at different magnetic field-strengths and the effects of parasitic fields. Moreover, the transparency of the tube is very convenient for the glass-blower, while the electron gun and the target are being sealed into their precise positions. The electron gun is small both in the axial and radial direction; hence its chance of being struck by electrons is less than with the usual type of construction.

If simplicity of equipment is desired, we may forgo the advantage of short-pulse injection and take a sinusoidal injection voltage from an auxiliary coil placed on the axis of the main coils (shown on the left of the photograph). The tension induced in this coil amounts to several kilovolts, from which the injection voltage can be tapped off at various points.

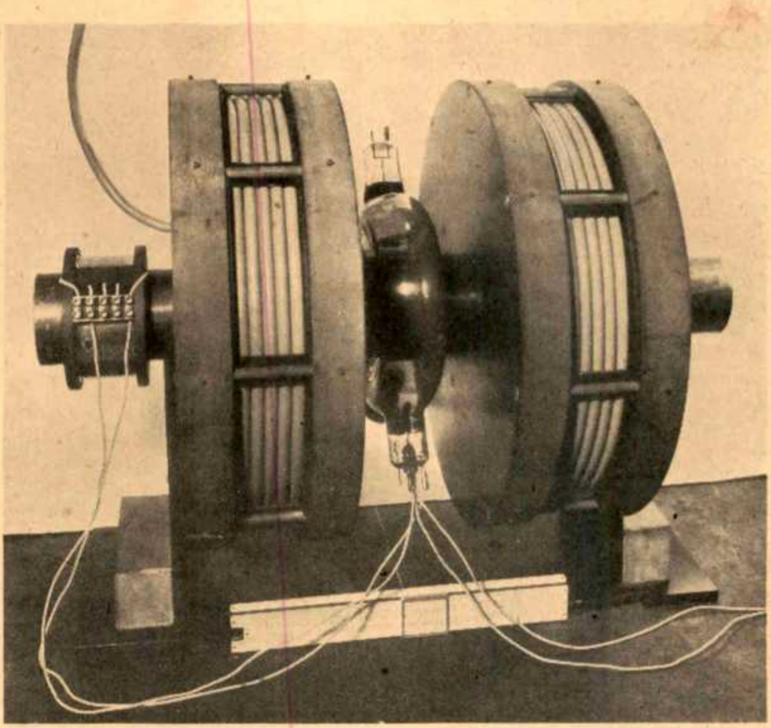
The current through the coils is supplied by discharging a 6·5 μF. condenser via a spark gap. The condenser is continuously loaded from a rectifier, and the spark gap breaks down as soon as the voltage across the condenser reaches a value of about 50 kV., so that the discharges are automatically repeated at intervals of a few seconds. It is also possible to arrange for a single discharge at a fixed moment, as is, for example, required for Wilson camera exposures.

Each discharge initiates damped oscillations with a frequency of 2,500 c./sec., in which the peak current through the coils attains a value of about 5,000 A. The power needed to maintain undamped oscillations would, with the present construction, be several thousand kilowatts, which makes continuous operation impossible because the dissipation would then be far too high. The small apparatus, shown in the photograph, is therefore only capable of producing radiation pulses at intervals of at least one second. Since after a few complete oscillations the current has been so much reduced that the iron core is no longer sufficiently saturated, only a few periods can be utilized in each discharge.

Though the mechanical forces resulting from the very heavy currents demand a solid construction of the coil frame, the betatron as a whole weighs no more than 50 kgm., the iron core itself weighing less than 5 kgm.

As the peak value of the magnetic field is 0·4 V.sec./m.^{2} (4,000 gauss) and the radius of the orbit is 8 cm., the energy of the accelerated electrons amounts to 9 MeV. This value can be reduced by exchanging the core for a smaller one which is saturated at lower currents; the contraction of the electron orbits will then take place at an earlier phase of the discharge. In this case a greater number of periods are utilized in each discharge.

It will be clear that in experiments requiring short-wave X-ray output during a brief period (as, for example, nuclear processes investigated with a Wilson camera) this type of betatron offers distinct advantages. Its simple construction makes the cost low, and it is light enough to be comparatively easy to handle;



9-MeV. betatron without an iron yoke. Slide-rule against base gives the scale it can, for example, be mounted on a mobile support. Moreover, the intensity of the radiation produced is greater than with the customary betatrons, for several reasons: because of the high frequency, the energy-gain in each loop is considerable (240 volts); this effects strong damping of the oscillations about the equilibrium orbit, while, moreover, the total path of the electrons is not more than 30 km. Consequently the loss of electrons by impact against the wall or against the molecules of the residual gas is considerably smaller than at the lower frequencies commonly used. In addition, a greater number of electrons can be accelerated at a time, owing to the large dimensions of the acceleration tube. Lastly, the axial symmetry of the magnetic field is more perfect than in an apparatus with pole pieces arranged in sectors, which again reduces the loss of electrons. Reliable data on the intensity of the radiation are not as yet available, but our experiments have already yielded evidence that the peak intensity is much higher than that obtained, in this laboratory, with a betatron of the customary type.

MULTIPLICATION AND DIVISION BY ELECTRONIC-ANALOGUE METHODS

By E. M. DEELEY and D. M. MACKAY
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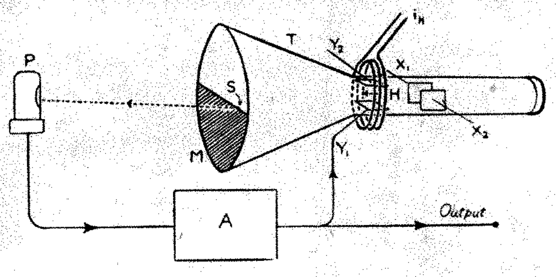
THE product or quotient of two rapidly varying quantities is difficult to obtain by conventional electronic-analogue methods. Desirable features in a multiplier include: (*a*) symmetry of response to positive and negative inputs; (*b*) an *absolute* indication of zero input, with consequent freedom from zero drift; (*c*) independence of normal changes in electronic characteristics; (*d*) rapidity and accuracy of response.

Techniques such as amplitude-, frequency- or pulse-modulation adapted from the field of communications have so far failed to provide all these features; most are fundamentally incapable of doing so. The object of this note is to direct attention to a simple principle which has been found to meet the above requirements[1], and which seems to invite wider application in this and related fields.

It is most easily described as a development of the principle used in J. J. Thomson's familiar method of measuring electron velocity, in which the force on an electron moving with velocity v at right-angles to a magnetic field H is counteracted by an electrostatic field E proportional to the product $H \times v$. If the adjustment of E were automatic and instantaneous, its value would be a continuous measure of this product.

The cathode-ray tube, which is well known to possess potentially all four virtues above, forms a convenient basis for experimental work. In Thomson's arrangement, however, v was the axial velocity of the electron stream, which is not a widely variable or reversible quantity. Accordingly, in the practical form of multiplier shown in essentials in the accompanying diagram, an axial magnetic field is used and v is the *transverse* velocity of the electron stream in the X-direction, proportional to a voltage V_x applied to conventional deflecting plates X_1, X_2. After X-deflexion, the stream passes through the magnetic field H, which produces a deflecting force, initially in the Y-direction, proportional to $H \times V_x$.



The Y-deflexion of the spot S on the screen, which would normally result (corresponding to a rotation of the pattern), is counteracted by a photo-electric feedback system of the type used in function-generators[2,3]. The photocell P, coupled to one of the Y-plates via the amplifier A, prevents the spot from deviating by more than a fraction of its diameter from the edge of the mask M. With care in adjustment of the latter, the spot can thus be held closely to the X-axis, and V_y is then proportional to the product of V_x with the current i_H producing H. Conversely, if the photocell is used to control H and voltages V_x, V_y are applied to X and Y plates, the current i_H is proportional to the quotient V_y/V_x.

Since the important parameters other than the accelerating voltage are purely geometrical, the prospects of attaining high stability in a device of this kind are good. Output is sensibly independent of changes in the gain of A, as usual in feedback circuits. At a later stage, it is hoped to dispense with the photo-electric link, using a collecting-electrode inside the tube to perform the combined function of cell and mask.

At the time of writing, it has not been possible to make a fair test of the accuracy and frequency-range of the technique; but it may be of interest to summarize the encouraging results of preliminary experiments with quite crude apparatus. A 931—A photomultiplier has been used, with a cathode-ray tube having a blue screen and running at only 500 V. to enhance overall sensitivity; D.C. and sinusoidal inputs up to 10 kc./sec. have been multiplied over the ranges ± 300 mA. and ± 20 V., with an accuracy of the order of 2 per cent at 50 c./sec.

Accuracy is limited in practice fundamentally by the signal to noise ratio attainable in the feedback path. Other important factors are the uniformity of the axial field, and its effective axial length, which should not greatly exceed that of the Y-plates. If magnetic X-deflexion were used, the Y-voltage would be practically independent of 'gun' voltage; but if electrostatic X-plates are employed for the sake of their high impedance, the output is directly proportional to the square root of the gun voltage, the stability of which is then an important factor in overall accuracy.

The importance of such devices to the physicist and mathematician lies chiefly in their application to the solution by analogue methods of differential equations with non-constant coefficients. A number of further applications of the same principle to high-speed electronic computing technique are being developed, and a fuller account of these and the above will be published elsewhere.

[1] MacKay, D. M., Brit. Prov. Pat. Spec. No. 11161 (1948). The same principle has been the subject of an unpublished independent investigation by D. J. Mynall.

[2] MacKay, D. M., *Nature*, **159**, 406 (1946).

[3] Mynall, D. J., *Nature*, **159**, 743 (1946).

THE SMITHSONIAN INSTITUTION

REPORT FOR 1946–47

THE annual report of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1947,* has now been published as a bound volume, including, besides the secretary's report and that of the executive committee, reports on the United States National Museum, National Gallery of Art, Freer Gallery of Art, Bureau of American Ethnology, International Exchange Service, National Zoological Park, Astrophysical Observatory, National Air Museum, Canal Zone Biological Area, and the Institution's library and publications. In a general appendix are reprinted a series of papers, some original, ranging over such diverse subjects as large sun spots, atomic energy, the use of isotopes as tracers, silicones, new products of the petroleum industry, drowned ancient islands of the Pacific basin, the biology of Bikini Atoll, the senses of bats, the influence of insects on human welfare, mosquito control tests, the primary centres of civilization, and the performance of propeller and reaction-propelled aeroplanes.

The reports from the National Air Museum and the Canal Zone Biological Area are the first to be included since these came under the administration of the Institution. The former, established in August 1946, is concerned mainly with the acquisition of a storage depot for the temporary assembly of material for the Museum. The latter includes the biological laboratory on Barro Colorado Island, which has already been responsible for much valuable scientific work. Some account of this work during the past twenty-four years is included in the present report. Studies cover the testing of wood for proofing against termites, the tropical deterioration of plywoods, textiles and packaging containers, and the effect of fungi on optical glass. Biologists go to the island regularly to study the fauna and flora, and there is a herbarium of 1,533 mounted specimens, as well as a species index containing about 7,000 entries. In addition to rainfall, temperature and relative humidity observations for 1946, the report records trials demonstrating the possibility of using treated timbers to build a termite-free house even where termites are extremely abundant and active.

Nearly 757,000 specimens went to the United States National Museum during the year, including two large and outstanding collections of fishes; but one of the most promising features of the year's work was an opportunity to resume field investigations of fifteenth-century historic Indian village-sites and some of the early Spanish settlements in the West Indies. Field studies were also made in Guatemala on the highland Maya for comparison with the lowland Maya of Yucatan; a survey of the fishery resources of Guatemala was continued and a botanical survey made of St. Vincent. The Bureau of American Ethnology continued the River Basin Surveys instituted in 1945 to recover archæological and palæontological information and materials which would be lost through the construction of dams and large reservoirs in many of the river valleys of the United States. Surveys in the Missouri Basin have been followed by others in Georgia, Virginia–North Carolina, Texas, California and the Columbia–Snake basin, while other investigations related to Eskimo anthropology, an Arctic Bibliography and Roster, the social organisation and ceremonial life of the Seneca nation, and cultural affinities between the northern Iroquoians and the Cherokee of the Great Smoky Mountains. Packages received by the International Exchange Service for transmission increased by 163,296 to 703,798, and the lag due to the War has been decreased to 69,020 lb. Consignments are forwarded to all countries except Roumania and Yugoslavia.

A slight improvement in the supply of animals for exhibition enabled the National Zoological Park to replenish the stock; but although some physical improvements were made, the Zoo was still understaffed. A list of additions and of animals, birds and reptiles in the Park is appended. The Division of Astrophysical Research was concerned first with appraisal of the solar constant values received from its field stations, with planning and developing improvements in instruments and methods, and with Camp Lee measurements of sun and sky radiation. The Division of Radiation and Organisms concentrated its work on the role of light, especially the wave-length effects, on the fixation of carbon by green plants, and on the influence of light on plant growth and development, particularly the mechanism of dormancy in light-sensitive seeds and the developmental physiology of grass seedlings. Of 62,137 accessions to the library, 14,607 went through the International Exchange Service, and 1,693 books were purchased. Like other departments of the Institution, the library was seriously handicapped by insufficient staff and accommodation, and overcrowding and lack of funds for binding caused progressive deterioration of its fine collections.

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* Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditure and Conditions of the Institution for the Year ended June 30, 1947. (Pub. 3921.) Pp. 471. (Washington, D.C.: Government Printing Office, 1948.) 2 dollars.

IODINE AS A MEANS OF DEVELOPMENT IN PAPER CHROMATOGRAPHY

By Dr. GUNNAR BRANTE
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IN a search for an agent for revealing the position of choline and other N-methylated alkanolamines separated by chromatography on papers, iodine was found satisfactory. It can be either directly sublimed on to the dried paper or sprayed in alcoholic solution, both methods having their special advantages. During the sublimation or spraying, spots of a brown to yellow colour develop, and they grow more distinct when any excess iodine or solvent is fanned away. Inspection in ultra-violet light sometimes makes the border-lines of the spots more easily discernible. As fading rapidly sets in, the spots are best judged immediately and outlined with pencil. After some heating or hanging at room temperature, the colour of the spots caused by most substances disappears completely. New iodine treatment then again reveals them.

After disappearance of the iodine, the same paper may, without any disadvantage, be developed by some other agent, for example, ninhydrin, the hexosamine reagent according to Morgan and Elson, general sugar indication reagents (ammoniacal silver

Rf values* of some amines and amine derivatives (Munktell *MOB'* paper, temp. 20–23° C.)

	Reaction to		n-Butanol, 40%; ethanol, 10%; water, 50%	n-Butanol, 40%; acetic acid, 10%; water, 50%	n-Butanol-phenol†
	Iodine	Ninhydrin			
I. Amino-acids					
Glycine	+	+++	0·16	0·32	0·04
Alanine	+	+++	0·22	0·39	0·09
Serine	+	+++	0·20	0·28	0·03
Threonine	+	+++	0·23	0·35	0·05
II. Amines					
Amino-ethanol	++	++	0·31	0·43	0·34
Histamine	+	++	0·32	0·25	0·73
Glucos-amine	+	++	0·30	0·28	0·09
III. N-methylated amines					
Monomethyl-amino-ethanol	++	+	0·41	0·45	0·49
Dimethyl-amino-ethanol	++	(+)	—	0·47	—
Choline	+++	—	0·19	0·45	0·45
Sarcosine	++	++	0·24	0·36	0·10
Betaine	+++	—	0·26	0·40	0·34
Acetylcholine	+++	—	0·31	0·48	0·60
Neurine	+++	—	0·23	0·46	0·55
Trimethyl-amine (-sulphate)	++	—	—	(0·43)	—
Trimethyl-amine-oxide	+++	(+)	0·36	0·54	0·61
Adrenaline	+	+	0·24	0·47	0·24
IV. Guanidine bases					
Arginine	+	+++	0·12	0·14	0·07
Guanidine	++	—	0·27	0·50	0·41
Guanidine-HAc	sl. +	—	0·21	0·39	0·12
Creatine	sl. +	—	0·22	0·37	0·11
Creatinine	+++	—	0·43	0·50	0·48
V. Purines and pyrimidines					
Adenine	sl. +	—	0·17	0·35	0·06
Xanthine	sl. +	—	0·12	0·36	0·05
Guanine	sl. +	—	0·13	0·37	0·12
Uracil	sl. +	—	0·13	0·34	0·08
Thymine	sl. +	—	0·13	0·36	0·07

* *Rf* values indicate the ratio between the distances of the substance and the solvent fronts from the initial position of the substances.

† 20 parts of water-saturated n-butanol mixed with 7 parts of water-saturated phenol were separated and the upper layer used in the trough.

nitrate, m-diphenylendiamine), picrate solution. After ninhydrin treatment, a paper may be developed by iodine (preferably by spraying) with similar results as though ninhydrin had not been used.

A great many nitrogen-containing compounds examined (in spots in most cases containing about 20–30 μgm. of substance) gave positive reactions of varying intensity and quality. I was especially interested in certain amines and their N-methylated derivatives, known or expected to be constituents of lipids. Most of the substances tested of this class gave very distinct and characteristic brown to flame-coloured spots. But various amino-acids, guanidine bases, pyrimidines, purines, etc., also were coloured, though in most cases much more faintly. Subsequent to iodine development most amino-acids gave the usual purple colour with ninhydrin; but some, for example, tryptophan, histidine and cysteine, retained iodine for a long time, thereby modifying the ninhydrin colour to a browner tint.

The method may be of value in qualitative analysis of mixtures containing only a few positively reacting substances. Thus it was found very suitable for my own purpose, namely, a study of nitrogenous constituents in lipid hydrolysates (to be published elsewhere). Data for some solvents used in these studies are collected in the accompanying table. Several other solvents have been tested and found less useful; thus it may be mentioned that in water-saturated phenol alone the methylated amines move unduly fast, and that nitrogenous solvents, due to their own reactivity with iodine, must be very thoroughly removed before iodine treatment, and therefore some of them are less convenient.

Due to their volatility, trimethylamine and dimethylaminoethanol do not appear at all, monomethylaminoethanol only with reduced strength on papers run in neutral or alkaline solvents in air. After adding one or two per cent of acetic acid to the solvent, the foregoing substances will be retained in the paper. Such solvent mixtures are now being studied.

Hitherto I have examined mainly substances which might be expected to be constituents of lipids or contaminants in lipid extracts. Purines and pyrimidines, owing to their slight solubility and faint iodine reaction, will probably not lead to errors in lipid analysis by the iodine reaction. On the other hand, the strongly reacting creatinine was identified in a distinct spot, deriving its origin from an alcoholic fraction of a lipid extract of a brain in uræmia.

In the table may be noticed several examples of the influence on its chromatographic behaviour of an OH- or CH_3-radical entering into a substance. This may be of some guidance in interpreting unknown spots.

Also in quantitative experiments with paper chromatography, iodine may prove convenient by revealing the position of the substances to be estimated; particularly as the iodine later sublimes, leaving outlined spots for excision, soaking and chemical or physical determination.

The ready formation of iodine addition compounds by amines and amine derivatives seems to be the cause of the iodine reaction, at least in most instances.

VISUAL AIDS TO EDUCATION

THE application of visual aids to education has been stimulated during the last decade mainly because the value of the still and motion picture projectors is being increasingly realized. Visual aids have existed for a long time; but it is only comparatively recently that their significance as an educational medium has been fully appreciated. This was recognized by the Havard Report on "General Education in a Free Society", which states: "Traditionally language deputises for what has to be absent. It tells us what we might see or hear. But it too often gets in the way of, or replaces, all that could give it a meaning. Now that the things and events themselves can be brought to us, the role of language is reversed. Instead of words having to explain or represent things, it is rather things or actual processes taking place before us, which explain words or call them in question."

To-day visual aids to illustrate and explain the written or spoken word are commonly used in the form of pictures, charts, diagrams and plays, while there is a growing interest in, and use of, still and motion pictures. The use of the latter in education was discussed by Mr. R. Beloe, chief education officer of Surrey County Council, in his address to the Education Section of the British Association at

Brighton. The address has now been reprinted by the National Committee for Visual Aids in Education.

Considering the place of the filmstrip projector as the successor to the old magic lantern, Beloe suggests that this device may be increasingly used, not so much as an aid to a lesson but as a lesson in itself, emphasis being placed more on the image seen than on the words read or spoken. More than the radio it could be used to project into hundreds of classrooms the identical ideas of a single teacher; every school should have its filmstrip library.

Yet however vast the potentialities of still pictures in education, those of motion pictures, which entertain for good or ill some 250 million human beings weekly, are even greater, particularly when full use may be made of natural colouring. Various investigations before 1939 recorded the value of the film in teaching. It helps children to remember; it awakens interest and secures sustained mental concentration; it stimulates, by putting a point of view different from the teacher's, and by compelling the pupil to find his own words to express opinions and to describe scenes; it supplies material for the exercise of reasoning faculties. In other words, it can enlarge the experience and broaden the outlook of pupils, and bring a sense of reality into the classroom. It can also broaden the outlook and knowledge of teachers and act as a stimulus to them.

By 1939, therefore, any doubt about the film's value as a teaching tool had vanished from the minds of those who had closely studied the matter. The real problem was one of logistics, and, until this was solved, little progress could be made.

The position was described in a 1946 report by Political and Economic Planning, from which it was made clear that there was a vicious circle. Lack of good educational films led to reluctance on the part of local education authorities to equip the schools with projectors. As there was, therefore, only a small market for educational films, it was not an economic proposition to produce them in great quantity. Recently it has been estimated that there are some two thousand instructional films of varying quality, types and value available in Great Britain. A large number of these, although for want of something better labelled as 'educational', are practically useless for teaching purposes. So far as can be ascertained, in 1946 there were fewer than four hundred sound projectors in schools in England and Wales. Of the 1,700 silent projectors available, many were unsuitable for classroom use.

These shortages of suitable films and projectors were due less to lack of enterprise than to lack of means. In the United States, where money is available, it has been stated that in the city of Los Angeles there are more than double the number of sound projectors in the whole of Great Britain. During the War the use of films by the armed forces of the British Commonwealth and also of the United States, as well as the lessons which had been gained from excellent documentary and propaganda films, again focused attention on the merit of the film as a teaching aid and on the paucity of supply.

In 1945 there was every reason on educational grounds why progress should swiftly be made in developing the use of visual aids by methods of projection as an integral part of teaching method. The lead was taken by the County Councils' Association, which, together with the Association of Municipal Corporations and the Association of Education Committees, as well as the National Teachers' Association, submitted a memorandum to the Minister of Education. As a result, two committees were set up in 1946. One, named the National Committee for Visual Aids in Education, was made up of representatives of teachers and local education authorities and had the duty of planning a visual education policy, collecting and collating views, nominating practising teachers as educational advisers to the producers of films, developing regional film libraries and encouraging authorities to purchase suitable films, advising on the supply, selection and maintenance of suitable apparatus and carrying out research. But the essence of the scheme was to be found in the Committee's relationship with the Minister. The Committee was to determine the films which are needed, and the Minister, subject to reasonable safeguards on the score of economy and the national interest, was to commission the films through a Production Committee, on which the National Committee, the producers of visual material and apparatus, the Ministry itself and the Central Office of Information were to be represented. The films thus produced were to be purchased by the authorities and schools.

At first the Central Office of Information was made responsible for the placing of films in production; but, in order that all suspicions of propaganda should be removed, it was later decided to set up a new organisation which would replace the Central Office of Information so far as educational films and other visual material was concerned. This body, the Educational Foundation for Visual Aids, is independent of the Government and has been supplied with a loan of £130,000, which is repayable to the Exchequer. Its function is, first, to market and distribute the films and other material which have already been commissioned.

Where commercial producers are prepared to take the financial risk of making a film they will be able to do so, and the Foundation will include the film in its catalogue of films, which it will supply at the stated price, receiving a discount from the production company. Where no producer is willing to take the financial risk the Foundation may either commission the film and retain the rights, or place with the producer an advance order for enough copies to enable him to finance the project. It is expected that, if necessary, the Foundation will take similar action with filmstrips.

Thus there has now been set up machinery to find out what films the schools require, for placing the work with the producers and for enabling both great and small to produce them, for providing the producers with advice from a practising teacher during production, and for marketing and distributing the finished articles.

Much more still remains to be done. First, there must be local libraries of all films likely to be in constant use by the schools, with facilities for teachers to view them. Secondly, there must be set up regional libraries for less widely required films. Thirdly, there must be a similar catalogue of filmstrips; but of these a library is needed in each school, for they are comparatively cheap and easily stored. Nevertheless, a central collection so that teachers may see what can be purchased for their schools will be needed in each authority's area.

Fourthly, the projectors for showing the material must be made available for purchase and must be purchased by local education authorities.

Fifthly, the local education authorities must make arrangements for the repair and servicing both of films and of apparatus.

Sixthly, but by no means least important, the teaching profession must be shown how to handle the medium. Up to the present the filmstrip and the film have been used mainly by enthusiasts. All teachers whose lessons can be improved by the use of visual aids should be trained to use them. It is therefore incumbent on all local education authorities to provide teachers with the facilities for acquiring that ability.

Lastly, a great deal more information based upon careful research is needed before educationists can regard themselves as masters of this medium. Scotland has produced two valuable reports which contain important statements about the subjects on which films should be made, the length of film suitable for children of various ages, and the value of sound films. These conclusions and others formulated in the 1947 Progress Report of the National Committee for Visual Aids in Education need testing. It is perhaps most important of all to ascertain the value of the film in teaching children of differing grades of intelligence and of its use in the teaching of adults.

T. H. HAWKINS

SUMMER SCHOOL IN ELECTRICAL ENGINEERING AT RUGBY

DURING July 12–16, 1948, the British Thomson-Houston Co., Ltd., held, at its Rugby works, a summer school in electrical engineering, which was attended by members of the staffs of the electrical engineering departments of universities and technical colleges, together with representatives of the Service colleges, the Ministry of Education, the Institution of Electrical Engineers, and Government research organisations. In the "Proceedings" of the school, published recently by the Company, are recorded the scientific papers presented by members of the Company's staff.

These papers give an interesting cross-section of the activities of a large electrical manufacturing organisation. Materials, for example, are represented by two papers, one on magnetic sheet-steel and the other on modern developments in electrical insulators. A review is given of some of the mechanical problems affecting the design of electrical machines. Several papers deal with design problems of the magnetic and electric circuits of rotating electrical machinery and one with the design of insulation for high-voltage transformers. Power systems receive attention in papers on switchgear, protective gear and power system analysis. Rather more than half the papers are concerned with electronics or high-frequency phenomena and applications. The fundamental theory of communication forms the subject of one paper, and magnetron generators, pulse modulators and micro-wave transmission techniques are covered by a group of papers. In the field of electronics there are contributions dealing with fluorescent discharge-lamps, arc control in gas-filled valves, the application of the mass spectrometer to leak detection in high-vacuum systems, and a development of the betatron.

One of the most valuable features of this collection of papers is the indication given in many of them of the trend of development and of the directions in which research in university departments could contribute towards the solution of some of the more fundamental problems. Having regard to the fact that these lectures were prepared by members of design and development departments as well as of the research department, it is perhaps worth while to record the impression that the scientific requirements of design and development are scarcely less stringent than those of research. Of particular interest is the opening address given by Sir John Cockcroft, in which the needs of Great Britain for scientific and technical staff are reviewed.

THE AGORA OF ANCIENT ATHENS: A STUDY IN ARCHÆOLOGICAL RECONSTRUCTION*

By PROF. HOMER A. THOMPSON
Institute for Advanced Study, Princeton

THE excavations which are being currently conducted by the American School of Classical Studies in the Agora, or civic centre of ancient Athens, have led to the identification and restoration of many ancient buildings through the combination of evidence drawn from ancient authors, inscriptions and the exploration itself. As a specimen to illustrate the procedure, the Odeum, or Concert Hall, may be selected.

The remains of the Odeum have been identified from a reference in Pausanias, the 'Baedeker' of the second century. Its date of construction is fixed in the Augustan period, partly by its architectural style, partly by the pottery associated with its foundations and partly by its specific name, the Agrippeum, which suggests that the building was erected by Agrippa, the minister of Augustus.

A close study of the foundations of the building and of scattered marble blocks from its superstructure has permitted the recovery of its architectural scheme in all essentials. The building proves to be unique in its dual nature, comprising as it did a core, in which were an auditorium, stage, dressing-room and lobby, and around the core a raised balcony that opened outward for the accommodation of spectators who might wish to view processions or ceremonies in progress outside the building. Of particular interest among the architectural details of the original period is the stage front, which was decorated with a marble screen supported by terminal figures alternately male and female.

The siting of the building on the axis of the Agora square is reminiscent of the contemporary Forum of Augustus in Rome, while its scheme of lighting through an open colonnade at one end was inspired by the Erechtheum; hence its design may be the work of a team of architects, some Greek and some Roman.

The building collapsed and was afterwards remodelled (as shown by stamped roof tiles) about A.D. 150. The remodelling involved reduction in the capacity of the auditorium from 1,000 to 500, and in the conversion of the original dressing-room into an open porch. The entablature of this porch was supported by six colossal marble figures, half of them Tritons and half Giants, both types being adaptations from statues of divinities in the pediments of the Parthenon. In front of the pedestals of these colossal figures were placed seated statues of philosophers. From the radical changes involved in the remodelling and from the fact that Philostratos (writing in the late second century) referred to the building as the scene of public lectures by the sophists, it may be inferred that in its second period the Agrippeum had become a university lecture hall and that its function as a concert hall had been assumed by the great new Odeum erected by Herodes on the south slope of the Acropolis about A.D. 160.

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* Abstract of a Friday Evening Discourse delivered at the Royal Institution on February 18.

A century later (A.D. 267) the Agrippeum was burned down by a band of barbarians, the Heruli, who sacked this part of Athens. The area lay desolate until about A.D. 400. Then above the ruins of the ancient building was erected a huge complex in the nature of a gymnasium which, in accordance with the Greek practice, would also have served university purposes. In the façade of the new building were incorporated four of the colossal figures from the old. The great structure of A.D. 400 was abandoned in the sixth century, presumably in consequence of the Emperor Justinian's edict closing the University of Athens (A.D. 529), and its ruins were buried by silt. Early in the nineteenth century three of the colossal figures were rediscovered and later re-erected, to be known as the 'Stoa of the Giants', one of the most prominent landmarks in the city and one of the most enigmatic until its riddle was solved by the current excavations.

TRAINING FACILITIES IN INDUSTRIAL RADIOLOGY

THE need for extending the available training facilities in industrial radiology was discussed at a meeting of the Industrial Radiology Group of the Institute of Physics held on February 18, at which were representatives of inspecting authorities, technical institutions, the Ministry of Education and industrial firms.

Discussing the necessity for adequate training of industrial radiographers, Mr. J. C. Rockley (Aeronautical Inspection Department) explained the system adopted by the Department, by which certain industrial radiographic departments and the radiographers in charge are 'approved' after satisfying the Aeronautical Inspection Department that the apparatus available is satisfactory for the intended purpose and that the radiographer has received sufficient basic training to be competent. A feature of this system is that if the radiographer moves to another department, his 'approval' is automatically withdrawn; the 'approval' of the department would also be withdrawn pending the appointment of a qualified successor.

Mr. F. C. Cocks (Lloyd's Register of Shipping) explained that the principal requirements for surveyors and other officers of inspecting authorities are provision for acquiring the technical background and experience in interpretation of radiographs necessary to satisfy themselves on the quality of the radiographic examination, and to assess the effect on the structure examined of an internal defect the shadow of which is seen on the radiograph.

Mr. F. Y. Poynton (Northampton Polytechnic, London) reviewed the present position with regard to technical institutions. Only very few technical colleges—among them the Northampton Polytechnic, London; the Royal Technical College, Glasgow; and the technical colleges at Chesterfield and Wednesbury—possess X-ray apparatus suitable for radiography, and none of these has equipment operating above 100 kV. peak. Most of the industrial radiography carried out, however, falls within the range of 150–400 kV. peak, or utilizes gamma-radiation; and it is under these conditions that most of the practical problems associated with scattered radiation, radiographic sensitivity and protection occur. Mr. Poynton said that steps are being taken to provide facilities for training in industrial radiography at the Northampton Polytechnic, London. The detailed form of these courses has still to be worked out; but considerable progress has been made in the provision of apparatus and the necessary laboratory and darkroom equipment.

Dr. L. Mullins described the courses being run by Kodak, Ltd., and explained that the basic introductory course occupies two weeks (75 hours) with an optional third week. This period has been adopted as the minimum in which the fundamental theoretical and practical training can be given, and because industrial firms are generally reluctant to release their staff for a longer period. He also mentioned more advanced courses in casting and weld radiography, lasting two weeks, and in shipbuilding radiography occupying three weeks.

Mr. N. Tunstall (Ministry of Education) said that the Ministry is anxious to participate so far as the demand for training facilities justifies; but it is very desirable that industry should make clear to local colleges the extent and nature of the demand for such facilities. The provision of short intensive courses would be a departure from the more usual method of training in a 'laboratory art', which is usually catered for by a course of part-time study lasting two years. The question of awarding a certificate of competence at the end of a full-time course of two or three weeks duration is one requiring a particularly cautious approach. H. S. Tasker

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, April 23—Saturday, April 30

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 10 a.m.—Public Exhibition of "European Housing in Prehistoric Times".*

Monday, April 25

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Adrien Albert: "Selective Toxicity with special reference to Chemotherapy".* (Further Lectures on May 2, 9, 16, 23, 30 and June 8 and 13.)

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. H. C. Walker: "Present Century Advance in Marine Engineering Science" (Science and Marine Navigation, 3).

Royal Institute of Chemistry, London and S.E. Counties Section (at Medway Technical College, Gardiner Street, Gillingham), at 7.30 p.m.—Mr. P. H. Prior: "Some Experiences of a Chemist in the Paper Industry".

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. George B. Cressey: "China's Prospects".

Tuesday, April 26

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. J. G. Peristiany: "Social Structure of the Pokot (Suk)".

Manchester Geographical Society (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Harry Milligan: "South Devon Story".

Institution of the Rubber Industry, London and District Section (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Annual General Meeting; Dr. L. R. G. Treloar: "Rubber Physics Up-to-Date".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Dr. K. Hoselitz: "Permanent Magnet Alloys".

Tuesday, April 26—Friday, April 29

Institute of Welding (at Beach Hotel, Southsea).—Spring Meeting.

Wednesday, April 27

Textile Institute (in the Public Hall, Lune Street, Preston), at 10 a.m.—Annual General Meeting; Sir Frederick Bartlett, F.R.S.: "The Application of Psychology to the Textile Industry" (Mather Lecture).

Physical Society, Low Temperature Group (at the British Oxygen Co., Research and Development Department, Lombard Road, Morden Factory Estate, Morden, London, S.W.19), at 2.30 p.m.—Dr. P. H. Sykes: Introductory Lecture; Dr. P. M. Schuftan and Mr. A. M. Clark will outline the work of the Development and Research Sections respectively.

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting; Prof. H. H. Read, F.R.S.: "Time in Plutonism" (Presidential Address).

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. Bronowski: "Some Uses of Statistics in the Building Industry—an Investigation into the Erection Times of Nine Types of Non-Traditional House".

Institution of Electrical Engineers, North-Western Radio Group (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Discussion on "Audio-Reproduction" (to be opened by Mr. G. J. Scoles, Mr. A. G. F. Smith and Mr. G. I. Thomas).

Royal Statistical Society, North-Eastern Group of the Industrial Applications Section (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. N. J. Squirrel: "Statistical Tables in Quality Control".

Institute of Industrial Administration, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. J. N. Toothill: "Productivity of the Engineering Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Giant Molecules".

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Conference on "Combined Heat and Power Supplies".*

Thursday, April 28

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Exhibition Meeting.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. Polya: "Symmetrization".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. Hugh Dryden: "The Aeronautical Research Scene—Goals, Methods and Accomplishments" (Thirty-seventh Wilbur Wright Lecture).

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8.15 p.m.—Dr. F. G. Spear: "The National Radium Commission in Retrospect" (Silvanus Thompson Memorial Lecture).

Friday, April 29

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Presentation of James Watt International Medal, and Special Lecture by the recipient, Dr. Fredrik Ljungström of Sweden.

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. E. D. van Rest: "Sequential Sampling".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Chemistry—The Principal, Wigan and District Mining and Technical College, Wigan (April 29).

Physicist—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (April 30).

Lecturer in Chemistry—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (April 30).

Director of Research (to be responsible for the control of technical research under the headings of Engineering, Metallurgy, Chemistry, Textiles, Paints, etc., as well as General Research)—The Secretary, Railway Executive, 222 Marylebone Road, London, N.W.1 (April 30).

Assistant Lecturer or Lecturer (Grade II) in Botany (Plant Physiology)—The Registrar, University College, Southampton (May 1).

Lecturer or Assistant Lecturer in Mathematical Statistics, and an Assistant Lecturer in Applied Mathematics—The Registrar, The University, Liverpool (May 1).

Lecturer (Grade I or Grade II) in Physics—The Secretary, The University, Birmingham 3 (May 1).

Assistant Director—The Director, Solar Physics Observatory, Cambridge (May 4).

Lecturer in Education (with qualifications in Science, preferably Chemistry or Biology), an Assistant Lecturer in Physics, and an Assistant Lecturer in Mathematics—The Registrar, University College, Leicester (May 7).

Mathematicians, Physicists and Aeronautical Engineers (unestablished Senior Scientific Officer and Scientific Officer grades) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.438/48A (May 7).

Professor of Botany—The Secretary, University College, Cork (May 7).

Lecturer (on probation) in the Department of Zoology and Comparative Anatomy—The Registrar, University College, Cathays Park, Cardiff (May 12).

Assistant Lecturer (temporary) in Agricultural Zoology—The Secretary and Registrar, University College of North Wales, Bangor (May 15).

Organic Chemist as research assistant to the Professor of Medical Chemistry, Australian National University, Euston Road, London, N.W.1—The Administrative Office in the U.K., Australian National University, Africa House, Kingsway, London, W.C.2 (May 19).

Head of Establishment (male) at the Air Ministry Survey Production Centre, Teddington—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2508 (May 19).

Lecturer (Grade III) in Electrical Engineering—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 20).

University Demonstrator in Metallurgy—The Secretary, Appointments Committee of the Faculty of Physics and Chemistry, University Chemical Laboratory, Pembroke Street, Cambridge (May 21).

Junior Lecturer in Mathematics—The Secretary, University Registry, Oxford (May 23).

Chair of Geography at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 25).

Chair of Botany at Royal Holloway College, Englefield Green—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 30).

Lecturer (with qualifications in Electronics) in the Fluid Motion Laboratory—The Registrar, The University, Manchester 13 (May 31).

Demonstrator in the Department of Entomology—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (May 31).

Nuffield Studentships and Fellowships for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 31).

Home Office Inspectors (2) under the Cruelty to Animals Act 1876 (experiments on living animals)—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2504 (May 31).

Lecturers and Senior Lecturers in Physics—The Secretary of University Court, The University, Glasgow (May 31).

Lecturer in Physics—The Secretary, The University, 38 North Bailey, Durham (May 31).

Laboratory Steward in the Physics Department—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18.

Lecturer in Chemistry—The Registrar, Municipal College, Portsmouth.

Fisheries Officers in the Federation of Malaya, and in East and West Africa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Abstractors to deal with technical and scientific literature relating to textiles, and a Librarian—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Technical Assistants in Royal Ordnance and Atomic Energy Factories and other Establishments, for investigation (under direction of senior engineer or chemist) of problems connected with either the production, development or maintenance and service sides of the factories and preparation of reports—The Ministry of Supply, Est.2(E)1, Room 403, Adelphi, London, W.C.2.

Technician (mainly to assist in research work) in the Department of Experimental Physiology—The Professor of Physiology, Medical School, Newcastle-upon-Tyne.

Assistant Librarian—The Secretary, British Internal Combustion Engine Research Association, 111–112 Buckingham Avenue, Slough, Bucks.

Junior Chemists or Physicists to supervise work involving chemistry and/or applied physics in the Division of Atomic Energy (Production) at Springfields Factory, Salwick, Lancs., and Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

Research Worker to conduct experiments in the biological aspects of 25 MeV. X-Rays and electrons—The Director, Cancer Clinic, City Hospital, Saskatoon, Sask., Canada.

Experimental Officer for two years' research on the physics of the pick-up of airborne droplets by flying locusts—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

Photographer for medical (non-clinical) and scientific work—The Secretary, Department of Physiology, School of Medicine, Leeds 2.

Graduate Chemist for work on the development of the use of wool grease and its by-products in the leather industry—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

Physicist, Chemist, or Engineer, to be responsible for the measurement and control of radiation hazards throughout the factory area, in the Division of Atomic Energy, Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy, Risley, Warrington, Lancs.

Chemists (2) for research concerned with the control of agricultural pests by chemical means, particularly by soil fumigation—Dr. A. B. P. Page, Imperial College Field Station, Silwood Park, Sunninghill, Berks.

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UNIVERSITY EDUCATION IN NATURAL SCIENCE

THE problems of education in science and of education through natural science were considered by scientific men and schoolmasters at the Dundee meeting of the British Association, and similar problems at the university level have now arisen in the University of Cambridge. A 'Syndicate' has been reviewing the regulations for the Natural Sciences Tripos, and the discussion of its report in the Regent House on February 22 showed that many in Cambridge have misgivings about the scientific education now being given to undergraduates. A number of tutors, directors of studies and college supervisors urged the need for drastic reforms. The position at Cambridge is probably similar to that at many other British universities, and merits the attention of all who are interested in the training of scientific men and citizens. Many of those who are closely in touch with the life and work of undergraduates are convinced that science students are being given so much formal factual teaching that they have no time for reading and reflexion. The study of the wider and more cultural aspects of their work is precluded and their intellectual development retarded. The courses of instruction seem generally designed for the production of specialist research workers; and specialization seems on the increase, in spite of the fact that only a small percentage of the students who read science become professional scientific workers. It seems to be overlooked that many will become teachers in schools, some will go into the Civil Service, others will join the administrative staffs of business or manufacturing firms; such students need a wider and more general training.

The present position in the universities of Great Britain has grown up gradually, often in the absence of any definite policy to guide the planning of the instruction given. In the past, the content of university courses in natural science was much smaller and there was less specialized science-teaching in the schools; students possessed some knowledge of the art of reasoning either through a study of elementary logic or, at least, through several years of regular lessons in Euclid. But the steady progress of scientific discovery has led to an enormous increase in the fields which students are expected to cover; both at school and at the university, philosophical instruction has been largely replaced by practical training. To-day a good memory rather than a well-trained mind seems to be the key to success. As a result, a science student may gain a high place in examinations, and yet be a very ignorant person when compared with many students of the humanities; and it has been said that the outside activities of young scientific men often show lamentable absence of that spirit of critical inquiry and resistance to propaganda which might be expected in those trained in exact knowledge.

Science students form a large proportion of the present undergraduate population of Great Britain, and they should contribute much to the future intellectual life of the country. We cannot afford to tolerate a system which produces a mass of narrow specialists for the sake of the few who may become workers in a particular scientific field. Graduates in science should have the well-trained minds and the breadth of vision which will enable them to take up administrative posts or to teach the principles of scientific thought in schools, as well as the details of some branches of scientific knowledge culled from text-books or from their lecture notes.

With the introduction into the schools of the new examination for a General Certificate of Education, it will probably be necessary for many university syllabuses to be revised. When this revision occurs, it is to be hoped that the question of education through science will receive careful consideration. Every university should provide some instruction in the methods of scientific thought and procedure—the grammar of science. How many of our undergraduates could to-day show the use of inductive and deductive reasoning in the subjects which they are studying, or give examples of hypotheses the reliability of which depends on the truth of postulates ? A training in the methods used to discover the truth about the phenomena of Nature should teach the student how to try to discriminate between truth and falsehood in the ordinary affairs of life. Some knowledge of the history of science is also of considerable importance ; not the kind of history which consists mainly of the dates when significant discoveries were made, with short biographies and anecdotes of great men of science, but a study of the historical background of science. Something of real educational value could be obtained from a knowledge of what men thought about Nature in the past, of the problems which confronted the natural philosophers, of the methods used for investigating these problems, and the difficulties which had to be met owing to imperfect apparatus, faulty observation or mistaken pre-suppositions. It is not suggested that the whole field should be covered, but only selected periods or subjects connected with the student's main lines of study. Lieut.-Colonel H. D. Anthony's book, "Science and its Background" (reviewed in *Nature* of September 4, 1948), shows that such a study can be made both interesting and useful; this mode of approach ought to be further developed at a university level. Sir William Dampier's "A History of Science" (Camb. Univ. Press), of which a fourth edition has recently appeared, is a standard work which must also be considered. An educated man of science should have some knowledge of the part which his own branch of study has played in shaping the material, intellectual and social progress of mankind. Many schoolmasters have realized the educational value of teaching about the operation of scientific progress as the greatest factor in the making of the modern world, but comparatively few young men who have taken university courses in science are competent, on leaving the university, to take an effective share in such teaching.

The problems of specialization also need close study. Too often a high degree of specialization in science begins at school, and no new subjects are studied at the university. This may set the student upon a path which he is not fitted to follow, and it often limits his education both as a citizen and as a man of science. The man who has only been trained in the physical sciences may fail to grasp the problems which arise when scientific methods are applied to heterogeneous living populations ; on the other hand, the student without a training in physics and chemistry may well be incapable of following modern experimental work in biology.

The reorganisation of university teaching along the lines which have been suggested will not be easy. It is not merely a question of introducing new courses into an already over-loaded time-table. The whole scheme of instruction needs review, with particular reference to the teaching of students during their first two years at a university. There may be considerable reluctance in some places to consider changes in the long-established routine; but it is vital to the nation that the thousands of men and women now studying science should be trained in the best possible manner. These students will in time become responsible for the progress of scientific knowledge, for our health, our food and for the education of our children; they will contribute to the administration of factories and commercial undertakings ; some of them will become Civil Servants, politicians and journalists. It is vital to ensure that students are imbued with a desire to ascertain truth by scientific reasoning, in order to fit them to give of their best in a world which is being deluged with propaganda of every kind.

PERSONAL AND HUMAN FACTORS IN INDUSTRY

Teamwork in Industry

By F. J. Burns Morton. Pp. xii+273. (London Chapman and Hall, Ltd., 1948.) 18*s*. net.

THIS book in essence is an essay on the theme o leadership, in the sense of which Arthur Bryant wrote in "Years of Victory", of evoking the will t serve rather than a mere matter of transmittin orders. "Unless we can discover and implement," writes Mr. Burns Morton, "means to ensure that me work willingly and harmoniously together, ou industrial efficiency will diminish, and with it ou trade in the home and foreign markets." The boo is frankly a contribution to the thinking and organisation which are indispensable factors in removin the present threat to our industrial future. Th approach is pragmatic but fundamental, and Mr Morton will clearly judge the worth of his work b the extent to which it contributes to the solution o what is now generally admitted to be the key proble in productivity—the establishment of right huma relations in industry.

Mr. Morton is fully aware, with Dr. Mayo and suc leaders in the theory of scientific management a Mary Follett, Colonel L. Urwick and Sir C. C. Renold that such relations involve society as a whole as we as the relations between management and th operatives within an industry. With his purpose o stimulating thought rather than offering cut-and dried solutions to particular problems, Mr. Morto directs his readers to most of the more stimulatin and accessible earlier works in this field. There are indeed, a few surprising omissions, and sometimes h asks rather much of his reader. A chemist, for example, might perhaps locate the late Prof. C. H. Lander's Melchett Lecture in the *Journal of the Institute of Fuel* without much difficulty; but the ordinary reader may well be at a loss for a clue in either time or space, if he wishes to verify or amplify Mr. Morton's brief quotation.

In his twelve chapters he ranges over such subjects as the human factor, team-work, job satisfaction, selection, training, incentives, leadership, supervision, discipline and social organisation. He starts by examining the causes of present difficulties, and passes in turn to review the social and economic changes which have taken place, to question the suitability of old methods for new problems and to outline the character of human behaviour. Here he insists on a change in policy or some adjustment in administration, there some modification in organisation or the introduction of new methods; throughout he insists on the necessity for training, from executives downwards, for more research in social psychology and industrial management, and for a widespread appreciation of human behaviour.

It would be easy to criticize some of Mr. Morton's observations as platitudinous; and some of the principles he emphasizes are well known, and are conspicuous in the planning that lay behind the successful operations of the War. Such criticism would be unjustifiable. Far too many of the precepts here displayed are still commonly ignored in industry. Moreover, Mr. Morton has here restated more incisively, in a form much freer from jargon and more attuned to British ears, much that is to be found in more diluted form in the vast American literature of management.

As the title of his book suggests, Mr. Morton sees the solution to our problem of productivity in the creation of team-work in industry. This he regards as a spontaneous reaction to environment and circumstances, secured voluntarily and not imposed from above; inspired by example in leaders, it is likely to follow rather than precede collaboration in the executive. It is concerned with external as well as internal relationships, and is a technique applicable primarily to the executives and not to be left to the single influence of a personnel manager. It can be developed by suitably planned measures and should not be left to chance. Its purpose, like that of management, is to make the most use of the man-power available.

The truth of Mr. Morton's diagnosis could easily be demonstrated in the experience of nationalized industry in Britain over the last two years. There the fundamental problem of human factor in industry—Can men be induced to strive efficiently as individuals and to work effectively as a group ?—is still unsolved. He would be a bold man who would contend that the National Coal Board has yet succeeded in creating the circumstances which encourage men to do as much as they can instead of as little as they must. It is equally clear that nationalized industry, no more than private industry, cannot confine its attention to problems of production and neglect for long its social obligations without risk of unfavourable reactions. It is still true, as Mr. Morton observes, that competition is necessary; it is the conditions under which competition operates that decide its value.

The book abounds in suggestive observations. Have we yet realized the implications of the vast difference between the casual attention of the repetition worker and the absorbed interest of the skilled technician ? This may only be a variation on the theme of craftsmanship, but it bears closely not merely on the creation of co-operation and team-work, but also on selection, the satisfaction a man finds in his job, on training, and on the negative as well as the positive aspect of incentives. Again, how obvious are the principles for giving orders which he lays down in his chapter on supervision, but how often they are ignored! Mr. Morton rightly holds that we need to examine the whole process of giving orders, to build up a technique for the use and guidance of executives in making themselves more effective and their subordinates more efficient.

This is but one of many suggestions for investigation or even research which Mr. Morton makes. On all these subjects he writes with insight, and nowhere more than on the problem of leadership and the conditions in which it can function. False ideas on such matters as joint production committees are dispelled, and if Mr. Morton lays the chief responsibility on the executives of industry for creating the conditions in which effective team-work is possible, he indicates what else is required, and the contribution to be made by trade unions and other bodies. A wise policy in which the idea of service is clearly to be seen can do much to evoke the response required from all engaged in the industry or firm; and this book can make a valuable contribution to the thought on which such a policy must be based and the constructive action required at so many points to deal with the problems arising out of human relations in all phases of industry and at all levels.

R. BRIGHTMAN

A REFLEXION OF SCIENTIFIC AND TECHNICAL PROGRESS

A Century of Book Publishing, 1848–1948

Pp. vii + 74 + 12 plates. (New York and Toronto: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.)

A HUNDRED years ago David Van Nostrand opened his bookshop in New York. Many of the customers were his personal friends, who came to discuss with him the merits of the latest books; and in a few years his office became more like a literary club than the bookshop of to-day. So popular was it that in five years he was obliged to move to more spacious quarters.

During a stay in New Orleans, Van Nostrand had come into contact with a group of distinguished army officers, and it is thus not surprising that when he opened his New York office there was a preponderance of military books, especially as the Mexican War had stimulated public interest in military history. At that time the functions of publisher and bookseller were not distinct, and as few technical books were written in the United States, the greater part of the business consisted of selling imported texts of high repute.

Van Nostrand soon became the largest dealer in scientific and technical books in New York, and then proceeded to extend his activities by publishing books which reflected the main interests of the period; thus some of the earliest, in the prospecting days, dealt with the mineral resources of the country. The threat of civil war gave an immense impetus to the demand for military and naval books, and Van Nostrand, appointed official publisher, issued a group which became classics.

From 1860 onwards, a new theme became apparent. This was engineering. Railway engineering was the subject of many notable books when railways and steel bridges were in course of development, but in the middle 90's this gave way to the rapidly growing science of electrical engineering. Civil engineering staged a revival about 1910, and was followed by mechanical engineering. Along with engineering, chemistry came to the fore, and works on the subject expanded at a remarkable rate. Nineteen books were listed in 1884, and more than two hundred in 1948. Not only the numbers but also the size increased. Scott's "Standard Methods" started with 870 pages in 1917 and the present fifth edition has 2,700. Chemistry received its main stimulus from the First World War, but it was not until 1925 that physics showed signs of expansion. In this case the chief development was due to the Second World War, the peak rate of production being reached in 1942 by a text-book on ultra high-frequency technique which was written in sixty days. 3,000 copies were reproduced by the offset process in 37 days and sold almost immediately. In two years 60,000 copies were sold.

The volume under review does not deal only with books; it gives an intimate picture of the working of the Company from the time when a normal edition was 1,000 copies, sold for more than twice their cost of production, to the present day with its planning and fierce competition. The personalities and achievements of the directors are set out at length, and it is difficult to avoid comparing David Van Nostrand at his roll-top desk discussing books with his customers by lamp-light, with the present group of distinguished men directing sales to unknown buyers. Is what we call progress really a measure of happiness? H. E. WATSON

ECOLOGY OF POTATO VIRUSES AND THEIR INSECT VECTORS

The Spread of Virus Diseases in the Potato Crop

By J. P. Doncaster and P. H. Gregory. (Agricultural Research Council Report Series No. 7.) Pp. 189. (London: H.M. Stationery Office, 1948.) 5s. net.

THIS is a substantial piece of work, born of war-time anxiety over possible inadequacy of potato seed supplies for necessary expansion in the acreage devoted to this crop. English growers import each year, from Scotland and Northern Ireland, enough seed to plant half their acreage. This is biennially discarded in favour of a 'change of seed'. There is no doubt about the general wisdom of this policy; but it is equally certain that many discarded stocks could have been grown for more than two years without serious deterioration.

An investigation of this possibility forms one of the major subjects of the present inquiry. We know that the spread of virus diseases, and particularly leaf-roll and rugose-mosaic or crinkle, brings degeneration of the stock. We have the results of numerous laboratory and greenhouse studies on these diseases. We had not, however, until the appearance of this report, an adequate idea of factors which influence the rate of spread of severe virus diseases in the lowland field. We still do not possess any practical method of assessing the suitability for further seed of a crop grown in ware-producing districts. There is a general indication, but a distinct lack of exact correlation, between the amount of virus spread and the numbers of virus-transmitting aphids. There are also incalculable variations between crop and crop.

A major portion of the report is devoted to the actual portrayal of results gathered faithfully by the authors and numerous collaborators, and condensed to intelligible proportions by the text-figures and appendixes. Of the four species of aphids regularly occurring on the potato crop—*Myzus persicæ*, *Aphis rhamni*, *Macrosiphum solanifolii* and *Aulacorthum solani*—the last two mentioned are deemed to play little part in transmitting leaf-roll and rugose-mosaic in the field. *Myzus persicæ* overwinters on peach and *Brassica* crops. A large amount of virus infection is probably accomplished by winged spring migrants; but Apteræ may be partly responsible at the peak of summer infection. *Aphis rhamni* overwinters on *Rhamnus*, though several heavy infections on potatoes have occurred in areas where buckthorn is rare.

The amount of infection within a crop depends far more on the number of diseased plants it contains than upon sources of infection more distant. Survival of diseased volunteer plants may bring about a large increase of virus. Fumigation of large plots with nicotine vapour destroyed the aphids, but had little effect on the spread of rugose-mosaic and leaf-roll. Probably the infection had already been effected much earlier in the year than is commonly supposed. The report, indeed, serves the useful purpose of turning our attention away from the summer maximum of aphids, and concentrating future work on insect-virus relations earlier in the season.

Though the report is somewhat negative with respect to its main target, it contains some very positive contributions along lines which might be called, without disparagement, by-ways to the main investigation. The chapter on development of the potato plant contains a lot of information which is relevant to the question of tuber-size control, now being developed so successfully in some seed-growing areas. The demonstration that a good deal of virus spread occurs much earlier in the year than was suspected may also find its greatest application in seed-growing areas. J. GRAINGER

PIG PRODUCTION IN GREAT BRITAIN

The Production and Marketing of Pigs

By H. R. Davidson. Pp. xvi + 535 + 96 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 30s. net.

THE British housewife has a weekly reminder of the poverty of the national larder in respect of pig meat; but she is not alone in regretting the recent drastic decline in pig production in Great Britain. Many farmers echo her regrets, and welcome, though cautiously, the signs that the agricultural stage is possibly being set for a real revival of pig-keeping as an essential and profitable part of British livestock industry. That there are now such signs makes this a singularly opportune time for issuing a comprehensive, and not unduly expensive, text-book on pig husbandry; and the opportunity is all the better served if authority in matter is matched with appropriate format, as it is here by Mr. H. R. Davidson and his publishers.

At last it is possible to give almost unqualified appreciation to a book in which the author seriously attempts to present a synthesis of modern work and ideas on nutrition, breeding and economics in relation to the management of a farm animal. From the width, and depth, of his experience as scientific worker and practical farmer, Mr. Davidson recognizes that animal husbandry is not just the sum of the components of breeding, feeding and management, but that the psychology of the animals as well as of their attendants enters into everyday problems and practices of stock-keeping. He recognizes also that the last words on any branch of husbandry are not yet said; he therefore adopts a strictly personal attitude in his treatment of data, observations and experiences, which adds to the usefulness of the book.

The scope is truly comprehensive. Part 1 reviews the general economic background of the British pig industry; it includes a series of analyses of the cost structures of pig enterprises and a particularly apt résumé of the history, and fate, of the pre-war marketing schemes for pigs and their products. Part 2, "Theoretical and Technical Considerations", brings together a mass of information on carcass qualities and trade matters, together with a valuable description of systems of carcass judging and evaluation; it gives a sensible presentation of the plain principles of nutrition, followed by a study of feeding practices, and proceeds to a discussion of the physiological, anatomical, and genetical aspects of pig improvement, and finally, to specific chapters on matters of housing and hygiene. Part 3 is devoted to critical accounts of the practical aspects of management, in which the author's experience is given as a helpful guide to the proper care and handling of pigs of all ages and stages.

The text is well and aptly illustrated by plates and diagrams; relevant data are conveniently tabulated for detailed consultation, or for neglect, at will; there is an extensive and appropriate list of references; and the index is effective. There are some, but only a few, minor typographical errors. Author and publishers have been remarkably successful in making available no mere compilation, but a work which, by reason of its judicial yet personal character and its range, sets a very high standard in literature suited to the needs of the progressive practical stockman, the agricultural student, and the scientific worker, as well as to the needs of the times. J. E. NICHOLS

RADON AND ITS APPLICATIONS

Radon

Its Technique and Use. By W. A. Jennings and Dr. S. Russ. (Published for the Middlesex Hospital Press.) Pp. x+222. (London: John Murray, 1948.) 18s. net.

It is a little difficult on reading this book to decide precisely for what class of reader it was designed. The treatment is, on the whole, elementary; but certain aspects of the subject, particularly those concerned with the technique of extraction, are dealt with in very great detail.

Certainly the first part of the book, where the subject of radioactivity is dealt with generally, will provide an excellent introduction to the non-specialist; and, with its clear exposition of the history of radon and its applications, it will convey to him something of the care essential in the handling of all radioactive substances.

The second part of the book is concerned with the details of the process of radon extraction. Separate chapters are devoted to the radium sources used, the extraction and purifying processes, the loading process, the measurement of gamma-ray activity and, finally, an analysis of the variation of content among groups of radon seeds. The treatment is didactic rather than critical. A wealth of detail is given of particular forms of apparatus, and a large number of numerical examples are given, illustrating methods of control and calculation. The methods described for the preparation of radon seeds are those that were used at the Radon Centre of the Medical Research Council; but little reference is made to the other method now used extensively, where the radon is led directly into gold capillary tubing.

The final section of the book deals with the medical applications of radon. Much of the classical treatment for dosage estimation with radioactive sources is given, and a number of nomograms and other types of graphical methods are described for the estimation of dose in particular techniques. A chapter on "Some Medical Considerations" is contributed by Mr. T. A. Green, whose methods of using radon are described in considerable detail. No attempt is made by the authors in this section to give a general survey of the ways in which radon is used.

Appendixes at the end of the book give some details of the recommendations of the British X-Ray and Protection Committee relating to radon, and some outline proposals for the lay-out of a National Radon Centre. Useful tables are also given of the rise with time of the gamma-ray activity of radon seeds and the hourly growth and decay of radon.

The book is well produced with clear diagrams and tables. The reviewer has noticed one or two small errors in the tables at the end. It contains much valuable information that is not collected together elsewhere; but some readers will regret that the authors chose to confine themselves to a discussion of particular methods and techniques rather than to make a comparison of methods and techniques in general.

ANTHROPOLOGY IN THE SOVIET UNION

Contributions to the Anthropology of the Soviet Union

Compiled by Henry Field. (Smithsonian Miscellaneous Collections, Vol. 110, No. 13: Publication 3947.) Pp. vii+244+5 plates. (Washington, D.C.: Smithsonian Institution, 1948.)

THIS compilation of the work of Russian archæologists and physical anthropologists covers a period of some ten years. The author is indeed to be congratulated on producing a volume which is absolutely indispensable for all archæologists and physical anthropologists outside the Soviet Union. One of the tragedies of the present world political situation is the lack of contact between Soviet researchers in these sciences and the rest of the world. How far any conclusions reached are coloured by their political theories of to-day cannot be discussed in this review; but certain it is that greater personal contacts would result in a greater understanding, not only of all the fine work which is being accomplished, but also in the attitudes of mind of researchers to their work.

The continued use of cultural terms—Clacton, Azilian, and the like—for cultures in Russia and the Crimea is also a matter needing discussion. The tendency in the West is to consider that these cultures have no wide distribution and that elsewhere at the same time other, sometimes allied but not identical, cultures occurred. The Gabrielle de Mortillet system was created for the situation in France; it strains and creaks when it is extended to apply to the whole world. Up to the recent War, the Roumanians took their culture in large part from France; but the resulting culture and the people of Roumania were not French. So many of these problems could be settled if greater contact with our Soviet colleagues was possible, and therefore we are indeed grateful to Mr. Henry Field, who has at least, in part, made liaison.

The volume deals first with the archæological situation in the Soviet Union, and later with the physical anthropology. It opens with an account of a conference called by the Academy of Sciences and held in Moscow during 1945, and which was attended by Mr. Field as the delegate of the Smithsonian Institution and other learned bodies in America. There follows an account of more than three hundred Stone Age sites recently investigated. Not all these are of world-shaking importance, of course; but many of them were entirely unknown to students outside the Soviet Union heretofore. The anthropological side, too, has not been omitted, and, besides a general account of recent work on the origin of the various inhabitants, there is a more detailed discussion arranged geographically of the different folk who people that vast area of the world's surface.

Certainly it is a volume to possess, and one can only hope that the author will continue to act as a 'liaison officer' until the happy day dawns when more direct contacts become easier. M. C. BURKITT

VIA SULPHONAMIDE

The Sulphonamides and Allied Compounds

By Dr. Elmore H. Northey. (American Chemical Society, Monograph Series, No. 106.) Pp. xxvii+660. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 75s. net.

THE chemists, Fritz Mietzsch and Joseph Klarer, and the pharmacologist, Gerhard Domagk, all working in the laboratories of the I.G. Farbenindustrie in Wuppertal-Elberfeld, synthetized and tested the first chemical compound to show specific chemotherapeutic protection in mice infected with lethal doses of hæmolytic streptococci. This historic occasion was probably early in 1931, since the German patent covering it is dated November 7, 1931. About a year later, on December 24, 1932, a patent was applied for to cover prontosil rubrum, a more effective compound, and this very great discovery must have taken place earlier in the same year. The first clinical report appears to be that of Dr. Foerster at the monthly meeting of the Dusseldorf Dermatological Society on May 17, 1933, and records the cure of a staphylococcal septicæmia in a ten-month-old boy by the use of prontosil ('Streptozon'). Late in 1935, Tréfouël, Tréfouël, Nitti and Bovet, at the Pasteur Institute, discovered that the chemotherapeutic action of prontosil, and of many similar molecules, was due to *p*-amino-benzene-sulphonamide, a metabolic product of prontosil. They went on to say, "The therapeutic activity of such a simple molecule which is itself not a colouring matter, opens the way to a systematic study of chemotherapy comparable to that which has been followed in the case of pentavalent arsenic". Time has clothed this scientific appraisal in the garb of classical understatement.

Domagk must have appreciated the significance of his great discovery, but he could scarcely have realized that he was ushering in a new era of bacterial chemotherapy. In a short span of twenty years the stimulus has produced important reactions in the allied field of protozoal disease and, in a broader sense of chemotherapy, in the allied fields of non-infectious disease.

By 1939 the literature of sulphonamide drugs had become enormous and the nomenclature chaotic, so that a grateful scientific world welcomed the original Northey review on sulphonamide drugs published in *Chemical Reviews*, 27, 85 (1940). The present monograph is the outgrowth of this review, revised and amplified; the new compounds now number 5,400. The system of nomenclature used in the original review and which received world-wide approval is used in the book, and is that developed by the author in collaboration with Austin M. Patterson. The general classification is a sensible compromise with Beilstein's "Handbuch der organischen Chemie".

There are twelve chapters, the first seven of which describe the nomenclature, classification and synthesis of sulphanilamide derivatives, related derivatives and sulphones. Chapter 8 is by Dr. H. J. White, of the bacteriological department of the Stamford Research Laboratories, and deals capably with the 'standard methods' and their pitfalls. There is a sound helpful chapter (10), by Dr. J. T. Litchfield, on the pharmacology, with special emphasis on absorption and distribution and which reflects, almost audibly, the teachings of the master, E. K. Marshall. There is also a comprehensive clinical survey by Dr. B. W. Carey, of the Lederle Laboratories Division. Chapter 11 is devoted to an unusually complete survey of the theories of the mechanism of action of sulphonamide drugs. The author has some sound and pleasing general observations, and he notes "that all theories are at best mere abstractions from reality which are approximately true under special conditions", and "new fundamental discoveries in the field are usually made by men able to think outside of the prevailing theories, or astute enough to recognize phenomena not conforming to the theories".

The formidable task of reducing to orderly dimensions the very heterogeneous collection of sulphanilamide derivatives and related sulphones is extremely well done. Beginning with a clear and logical nomenclature, some thousands of derivatives are listed and classified, the various categories being tabulated in the table of contents and the index. Having mastered the (simple) rules of Chapter 2, the reviewer made several trial excursions and emerged, to his satisfaction, with the compound sought. A random sample (2 per cent) of the 2,668 references quoted found meticulous accuracy.

The book is well printed on good paper, but the tables are indifferently set; it is expensive.

GEORGE BROWNLEE

British Rainfall 1946

The Eighty-sixth Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over Great Britain and Northern Ireland during the Year 1946 as recorded by about 5000 Observers. (Air Ministry: Meteorological Office, M.O.495.) Pp. v+214. (London: H.M. Stationery Office, 1948.) 21*s.* net.

"BRITISH RAINFALL" makes a welcome reappearance after a gap of six years, the latest preceding volume being that for 1939. There are some changes of format, and a number of the maps are missing; but the essential features, so necessary in planning the best use of water, remain. These include, besides the distribution of monthly, seasonal and annual rainfall and raindays, chapters on dry and wet spells, duration of rainfall, heavy falls, evaporation and percolation; all are plentifully illustrated by tables, and there are still a good many maps. It is pleasing that the coloured chart of rainfall as a percentage of normal remains. But the text is necessarily curtailed, and well over half the volume consists of the "General Table" giving the annual totals of rain and raindays, and the long-period average rainfall for about 5,000 stations.

The introduction emphasizes that such a vast fund of information is only made possible by the enthusiasm of a large body of voluntary observers, some of whom have maintained their records for many decades. The volume records the deaths of two observers—Sir John Eldon Bankes and the Mackinnon of Mackinnon—of seventy years standing, and seventeen others of more than thirty years. Unfortunately, the "General Table" lacks the records from Eire, which has now its own meteorological service. The data for 1940–45 are to be published shortly in two three-yearly volumes.

New Syllabus Algebra

By C. O. Tuckey and W. Armistead. Pp. viii+201. (Cambridge: At the University Press, 1948.) 5*s.* net; without Answers, 4*s.* 6*d.* net.

THIS is a really modern book on algebra, designed to cover those parts of the subject which are of special interest and importance. It is based largely upon the recommendations suggested in a report issued in 1944 by a representative conference of examining bodies and teachers. In this report it is stated that "The transition from static mathematics of the formula, which enables one quantity to be calculated when another is known, to the dynamic mathematics of the function, which considers how one thing changes with another, is one of the chief ways in which mathematics has adapted itself to the consideration of practical problems". As the authors point out in the preface, this course of algebra has been "arranged according to the types of function to which various processes are applied instead of the customary division according to types of manipulation". A feeling is thus created for functionality which can be developed at an early age.

The book is divided into three parts: the beginnings; proportion and linear functions; squares, areas and quadratics. The new method for factors, given on p. 142, was taught by the reviewer for many years. Its logical conciseness renders it particularly interesting to pupils, and any legitimate method which serves to stimulate interest is manifestly worth while. The method may easily be extended to include cases where the coefficient of x is other than unity. A fundamental place is given to the pupil's concept of functionality by introducing ideas of the gradient and of the derivative of quadratic functions.

The whole course is thoroughly sound and skilfully written, a special feature being the last few pages devoted to topics of algebraical interest, for these will bear out "the desire to bring mathematics more closely into relation with the life and experience of the pupil". Answers are provided, and there is a single-page index.

F. G. W. BROWN

The Essential Oils

By Dr. Ernest Guenther. Vol. 1: History, Origin in Plants, Production, Analysis. Pp. xvi+427. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 33*s.* net.

THIS collaborative work has behind it the resources and experience of Fritzsche Brothers of New York, well known as producers of essential oils. Dr. E. Guenther, a vice-president of the firm, discusses the technique of essential oil distillation, from the broadest principles of the binary distillation diagram down to such details as the effect of pressure differential within the still in liberating the oil from the plant cells. Enfleurage and solvent extraction, and the preparation of terpeneless oils, are illustrated from Messrs. Fritzsche's practice and also from that followed in Grasse and elsewhere. Mr. E. E. Langenau, director of the firm's analytical laboratories, describes in working detail the determination of the analytical characters of essential oils, and the estimation of impurities, adulterants, and constituents of particular importance such as cineole and stearoptene. A director of the American Institute of the History of Pharmacy (Dr. George Urdang) sketches the history of the industry; and a professor of bio-organic chemistry (Dr. Haagen-Smit) discusses the pure chemistry of the chain- and ring-systems encountered, and the plant physiology of their formation. The section on the functions of the oils in plants offers, perhaps, too many tentative solutions of this question for any of them to seem very satisfying; analogously to the famous theologian in meditation on the cosmos, the reader may begin to feel that he has learned every possible thing about essential oils except why God created them. The scope outlined for future volumes of the work, however, suggests that even this uncertainty will, in due time, be resolved.

Rhenium

Dvi-Manganese, the Element of Atomic Number 75. By Dr. J. G. F. Druce. Pp. viii+92. (Cambridge: At the University Press, 1948.) 10*s.* 6*d.* net.

THE discovery of rhenium in 1925 was quickly followed by widespread and intensive research on its properties, so that, within seven or eight years, sufficient information had become available to enable several authors to produce monographs on the element. Since then, a considerable amount of further knowledge has been accumulated, so that a new publication is to be welcomed. Dr. J. G. F. Druce should be well qualified to undertake this task, for he has been actively interested in rhenium throughout its history. His monograph covers the subject fairly well and provides a useful summary of the chemistry of the metal and its compounds. Unfortunately, however, it gives the impression of having been hurriedly written. For example, on page 14 a description is given of the systems tungsten–rhenium and phosphorus–rhenium, and this is again repeated on page 66. Furthermore, in describing potassium perrhenate the statement is made (p. 40), "Its density is about

4·89. In toluene, however, Biltz found the value 11·4." This latter value is obviously incorrect and, indeed, has nothing to do with potassium perrhenate, but is, actually, the density of rhenium dioxide. Then again, on page 16, a table is given of the principal lines in the optical spectrum of the element, which is stated to be "by Loring", whereas it is due to W. F. Meggers and is merely quoted by Loring in an article.

At the end of the text there is given a chronological bibliography which the author claims to be complete and to have been compiled with great care. It is, however, not complete and even omits one or two references which have been mentioned in the text. Moreover, the reviewer found at least a dozen errors of one kind or another in it. Nevertheless, the bibliography is very useful and is reasonably complete, particularly with regard to papers dealing with the chemistry of the metal and its compounds. G. R. DAVIES

The Students Handbook to Foundations of Animal Feeding

By L. T. Lowe. Edited by G. H. Purvis. (Published for the Monmouthshire Institute of Agriculture.) Pp. 93. (Worcester: Littlebury and Co., Ltd., 1948.) 8*s*. 6*d*. net.

THIS small book, according to its dust-cover, purports "to provide as concisely as possible essential modern technical and scientific information for those engaged in training and advising agricultural students of all kinds, and especially those at agricultural and horticultural institutes", in which activities author and editor have considerable experience. Unfortunately this reviewer holds the opinion that clarity is preferable to conciseness and repetition, and that punctuation and careful proof correction are essential in even the most elementary scientific texts. Moreover, he also doubts whether acquisition of a patter reflects a thorough appreciation of principles. For these reasons he finds this compilation disappointing. Even if the purpose were to provide only a handy reference, little is gained by adding an eight-page glossary which mainly repeats or paraphrases explanations in the seventy-page text, or by separating "Index, Animal Nutrition" from "Index, Feeding Stuffs". J. E. NICHOLS

Your Body and the Way it Works

By Prof. Winifred Cullis. (Understanding the Modern World Series.) Pp. 32. (London: George Allen and Unwin, Ltd., n.d.) 3*s*. 6*d*. net.

IN her broadcasts to schools and lectures to members of the Armed Forces, as well as in instructional films, Prof. Winifred Cullis has gained an enviable reputation as a popular interpreter of human physiology. In her latest little book she adds to that reputation by successful collaboration with Ian Morrison, an accomplished artist who has also had experience of teaching physiology to young people in school. As in other books in this series, the author expresses herself largely through the artist, each topic being presented visually rather than prosaically. The section dealing with the brain and nerves, for example, contains enough diagrams with suitable legends to enable the young reader to understand the general working of the human nervous system. The diagrams have been ingeniously devised and well drawn in attractive colouring, and should stimulate sufficient interest to lead the reader at once to the accompanying text, which has been clearly thought out to fit in with the diagrams. Particularly fine sections are those dealing with the special senses and reproduction, the latter containing one diagram making crystal clear a point which teachers find so difficult to convey to young students, namely, the exchanges between embryo and mother in the placental circulation where the two blood circulations do not themselves mix. The book also contains a useful supplementary section indicating practical hints of what may be done to test the statements made in other parts of the book. T. H. H.

Photographic Surveying

By Colonel B. B. Talley and Paul H. Robbins. Pp. v+223. (New York, Chicago and London: Pitman Publishing Corporation, 1945.) 24*s*. net.

THIS book has been written as an introduction to the subject for those who may be concerned with photogrammetry, either from the aspect of flying and photography or as engineers who wish to make use of it, rather than for those who wish to gather a detailed knowledge of the processes. As the authors remark in the preface, "Engineers especially find that a basic knowledge of the subject is essential for full understanding of the possibilities to which photography may be put. Especially is this true of Civil Engineers. . . . The Armed Forces have been quick to realise this as is evidenced by the inclusion of this subject as part of the basic training for members of the air forces."

In view of its purpose the book is mainly descriptive in character and is profusely illustrated. It is very readable and should be easily understood by those who wish to acquire the outlines of the subject. The treatment is from the American aspect, British practice not being mentioned, although a number of European instruments are referred to. The inclusion of more than a passing reference to multi-lens photography and its rectification is somewhat surprising, because the almost universal use of wide-angle single-camera photography has superseded it except for the assembly of three cameras—generally known as Tri-Metrogon—for reconnaissance mapping. With these reservations, the book can be thoroughly recommended to those who wish to gain a general idea of the subject. C. A. H.

Das Pflanzenkleid der Mittelmeerländer

Von Prof. Dr. M. Rikli. Three vols. Pp. 1418+200 plates. (Bern: Hans Huber, 1943, 1946 and 1948.) 122.50 Swiss francs.

VOL. 3 completes Prof. Rikli's authoritative and unique work on the Mediterranean countries, a work which, in addition to assembling a vast amount of botanical information on the region, depicts the effect upon the plant cover not only of climate, but also of the various civilizations, old and new, which have made their mark upon the Mediterranean.

The first two volumes have already been reviewed in *Nature*, 152, 117 (1943); 153, 445 (1944); and 160, 416 (1947). The third and final volume supplies an author index and a very full genera and subject index combined. The greater part of the volume, however, is occupied by a list of the pertinent literature, which comprises 3,700 titles classified according to subject, the entries under regional plant geography—a very large section—again being subdivided geographically. Further, there is a list of the author's extensive travels in the region over a period covering 1889 to 1936, lists of the plates, figures in the text and maps of plant distribution, and an index of the countries, places and civilizations treated. G. M. ROSEVEARE

PHYSICS AND CHEMISTRY OF HYDROCARBON GELS

On March 24, a Royal Society Discussion was held on the subject of the physics and chemistry of hydrocarbon gels. Interest in these systems arose in the first instance from the desire to extend the range of flame throwers in which hitherto ordinary liquid hydrocarbons had been used. It was evident at a very early stage in the investigation that a possible improvement in range could be effected if the fuel could be made thixotropic in character, or at any rate if its intrinsic viscosity could be varied over wide ranges on changing the rate of shear. Further investigation revealed the fact that another physical property or combination of properties embraced under the term 'stringiness' or 'extensibility' had also to be taken into consideration.

Since gels are two-phase systems, inquiry centred around the preparation of suitable hydrocarbon gels. The gel-forming polymeric network could be introduced into the hydrocarbon by swelling and dispersion, or could be formed *in situ* as a result of suitable chemical reaction. Of the former, the early rubber–petrol systems were soon replaced by *iso*-butylmethacrylate or by cellulose acetate in a suitable fuel solvent, whereas the aluminium soaps of fatty acids were found to be most suitable among the latter class.

A linear polymer will dissolve in a hydrocarbon if the free energy of solution ΔF is negative. A high heat of solution ΔH may counterbalance the large (for polymers) entropy ΔS of solution. If $\Delta F = \Delta H - T\,\Delta S$ is positive, complete solution does not occur, but there results a swollen gel in equilibrium with almost pure solvent.

The degree of swelling of the gel phase is determined by a solvent-polymer interaction term μ. For linear polymers, μ can be defined by

$$\Delta F = RT \log (1 - \nu) + \nu\left(1 - \frac{1}{n}\right) + \mu\nu^2,$$

where ν is the volume fraction of the polymer and n the ratio of solute/solvent molecular weight.

For a cross-linked polymer, the free-energy term must include not only the change due to dilution, but also the elastically stored free energy in the swollen network; expressions for this term, both for equilibrium strain-free and strained conditions, were described by Dr. L. R. G. Treloar.

This elastic energy may be stored as orientation entropy in the flexible chains, as potential energy in bent or stretched valency bonds or as a twist against the hindered potential opposing free rotation about the C—C axis. In the case of an isolated long-chain molecule, Kuhn showed that the force per unit extension would be inversely proportional to the number of bonds for orientation entropy and inversely proportional to the square of the number for twisting against hindered rotation.

The molecular spring in a gel is the average strand between two junction points in the framework, and the number of junction points as well as the number of strands is evidently proportional to the square of the volume concentration. The average length of a strand is, conversely, proportional to the concentration; consequently, the rigidity of the network should be proportional to the square of the volume concentration for the energy stored in the chain entropy, and to the cube of the concentration for twisting against hindered rotation. Data on the rigidity of gels as a function of the concentration of gelling polymer are scanty; but, such as they are, they suggest that twisting of the chains against hindered rotation rather than bond extension or chain entropy is the main factor involved.

It is evident that to obtain a fuller understanding of this partition of polymer between swollen gel and dilute solutions as separate phases, a close examination of the phase behaviour of polymer and solvent is desirable. Dr. A. E. Alexander gave an account of the examination of the swelling and solubility of cellulose acetate in benzene–xylenol mixtures. He has found that the solubility of the acetate in benzene–xylenol mixtures is greatly influenced by the degree of acetylation. By comparing the solubilities and swelling powers of the separated fractions in benzene–xylenol mixtures of different compositions, it has been shown that preferential adsorption of the xylenol takes place from these mixtures, and from the two sets of experiments phase diagrams have been constructed which when superimposed on one another reproduce the data obtained with the original material.

The rather complex rheological properties of these 'thickened' hydrocarbon systems were the subject of several communications, including those of Dr. A. H. Nissan, Dr. K. Weissenberg and Mr. R. S. Rivlin.

While the majority of these polymer-containing hydrocarbon systems are thixotropic in character and thus can store potential or elastic energy when distorted, they all exhibit the property of anomalous viscosity or non-Newtonian flow; indeed, the intrinsic viscosity may vary as much as a millionfold when the rate of shear is changed.

The point of thixotropic breakdown is now generally associated with a balance being achieved between the rate of cross-linking or bond formation and bond breaking, and it is evident that if these can be regarded as independent rate processes, the anomaly in the viscosity shear curves can readily be interpreted. Attempts have also been made to apply the considerations advanced by Eyring to these systems; but the physical interpretation of the actual mechanics of the processes involved on this basis is by no means clear. One of the most interesting conclusions arrived at from theoretical argument is the fact that to describe the flow properties of these solutions, two, and not one, physical parameters are required. If viscosity be chosen as one of them, the other is a normal stress coefficient. In a steady state of flow the normal stress coefficient may not vanish and will give rise to many of the effects which these anomalous liquids exhibit.

A great deal of attention has been devoted to the aluminium soaps as gelling agents for hydrocarbon fuels, and communications on this subject were made by Dr. A. E. Alexander, Dr. G. A. Parry and Dr. J. H. Schulman. Aluminium exhibits six-fold co-ordination and is amphoteric in its salts. The simplest compounds may be regarded as derivatives of $[\mathrm{Al}(\mathrm{OH})_6{}''']\,\overset{+}{\mathrm{H}}_3$ (aluminic acid) and $[(\mathrm{H_2O})_6 \rightarrow \overset{+++}{\mathrm{Al}}]\,\mathrm{Cl}_3$ respectively. Salts of the type $[(\mathrm{H_2O})_5\ \mathrm{Al}\ \overset{++}{R}]\ \overset{-}{R}_2$ can evidently be prepared.

Bjerrum and Stiasny were the first to examine the condensation of these substances by the elimination of water by processes they termed 'olation' and 'oxolation', and condensation polymers up to the tetramer can readily be identified.

For the purposes of gelation, the anhydrous aluminium soaps are most readily prepared by reaction of the aluminium alkoxides formed by direct interaction of the metal with the alcohol and fatty acids in an organic solvent, although similar results can be obtained from freshly precipitated aluminium hydroxide and the free fatty acids, or by ordinary metathesis between an alkali metal soap and an aluminium salt.

There still appears to be a certain amount of doubt in respect to the nature of the soaps of aluminium. The existence of di-acid soaps, $Al(OH)L_2$ and $Al(OR)L_2$, where L is the acid radical, is well established both by Karl Fischer's method for water determination and also calorimetrically from the heats of neutralization. Neither the tri- nor mono-soap appears to be readily prepared, at least from aqueous solutions, the product consisting mainly of the di-soap with adsorbed free fatty acid or hydrated alumina.

The complexes formed in strong solutions can be broken down by means of peptizing agents. Their mode of action can be ascribed to the breaking of the aluminium oxygen co-ordinate links by preferential co-ordination with the peptizer, and thus a large variety of compounds, such as water, amines, pyridine, alcohols, and, after that, phenols and fatty acids, can serve as peptizers.

ERIC K. RIDEAL

VARIABLE AND CONSTANT COMPONENTS OF CHROMOSOMES

By DR. A. E. MIRSKY and HANS RIS
Rockefeller Institute for Medical Research, New York

A STUDY of isolated chromosomes has shown that they contain desoxyribonucleic acid, histone and another protein of an entirely different character from a histone[1]. This protein remains as a microscopic fibre after extraction of desoxyribonucleic acid and histone from the chromosome. The coiled thread that is left after removing desoxyribonucleic acid and histone is called a 'residual chromosome', and the protein of the thread is referred to as the 'residual protein' of the chromosome. Some ribonucleic acid is combined with residual protein. The thread of residual protein is the basis for the thread-like structure of the chromosome. In the isolated chromosomes that were first prepared, those of nucleated erythrocytes of the carp and of calf thymus, the residual protein represented only 4 and 8·5 per cent respectively of the dried mass of the total chromosome, the remainder of the lipid-extracted chromosome being almost entirely nucleohistone.

Isolated chromosomes have now been prepared from beef liver, kidney and pancreas. For this purpose it was necessary to add several steps to the original procedure, for otherwise the chromosomes obtained were contaminated with considerable quantities of non-chromosomal material. In a suspension of isolated chromosomes, morphologically different individuals can be identified, and the same chromosomes are found in preparations from thymus, liver, kidney and pancreas of the same organism. This recognition of chromosome individuality in preparations of isolated chromosomes from different tissues is especially striking when the chromosome is the one to which a nucleolus is attached.

Fractionation of liver, kidney and pancreas chromosomes shows (figures given in Table 1) that their composition differs markedly from that of erythrocyte and thymus chromosomes, in that the former contain less nucleic acid and far more residual protein.

The composition of a chromosome appears to be related to the nucleo-cytoplasmic ratio of the cell in which it is located. Thymus lymphocytes have only a scanty cytoplasm compared with the abundant cytoplasm present in most cells of the liver, kidney and pancreas. We find that the nucleus represents 60 per cent of the mass of thymus cells and only 10–18 per cent of the mass of cells of the liver, kidney and pancreas. Chromosomes of nucleated erythrocytes, as seen in Table 1, have a composition that would be expected if they were in a cell with scanty cytoplasm. They have, in fact, a large cytoplasm, but one that is relatively inert metabolically. This shows that what is significant in the relationship between nucleo-cytoplasmic ratio and chromosome composition is the metabolic activity of the cytoplasm, as well as its bulk. Further evidence may be cited relating chromosome composition to nucleo-cytoplasmic ratio of the cell. The lymphocytes in the lymph nodes of beef contain far more cytoplasm than do the lymphocytes of calf thymus; and, in accordance with the rule that has just been mentioned, the nuclear substance of lymph node lymphocytes has a much lower percentage of desoxyribonucleic acid. The nucleo-cytoplasmic ratio of liver cells changes considerably when an animal fasts. In fasting, there is a decrease in the ratio of cytoplasm to nucleus. In these circumstances we would expect to find the percentage of desoxyribonucleic acid in the nuclear substance of liver cells to increase during fasting—and analysis does, indeed, show this.

Table 1

Chromosomes of:	Desoxyribonucleic acid (per cent)	Residual protein (per cent)
Carp erythrocyte	41	4
Calf thymus	39	8·5
Calf liver	26	39
Calf kidney	28	33
Beef pancreas	28	29

From the data given in Table 1 it cannot be said whether the differences in percentage composition of chromosomes of different cells of the same organism are due to variations in the quantity of nucleic acid or in the quantity of residual protein present in a given chromosome. When cytologists observe differences in staining of chromosomes, they frequently conclude that more or less chromatin is present in the chromosomes. The material in the chromosome that stains (chromatin) is desoxyribonucleic acid, and in the cytological literature there are many statements, based on staining, concerning an alleged increase or decrease in quantity of desoxyribonucleic acid in chromosomes. What is actually being observed is a change in percentage composition. An apparent decrease in quantity of nucleic acid (chromatin) may be simply a decrease in the percentage of nucleic acid due to an increase in quantity of residual protein in the chromosome, the actual quantity of nucleic acid in the chromosome possibly remaining constant.

The quantity of nucleic acid in a single nucleus can be determined if the number of nuclei can be counted in a given mass of material used for analysis. For some cells, those of liver, for example, this is readily accomplished by isolating a mass of nuclei using the citric acid method and counting the number in a given volume of the suspension. In other cases, erythrocytes and sperm, the cells themselves can be counted. A comparison of the desoxyribonucleic acid contents of the nuclei of the erythrocyte and liver cell of the domestic fowl is of interest. Analysis of dried liver nuclei shows that 21·8 per cent is desoxyribonucleic acid, whereas of the dried erythrocyte nuclei 40·4 per cent is desoxyribonucleic acid. Despite this difference, the *quantities* of desoxyribonucleic acid per nucleus are found to be identical for these two nuclei. The analytical figures for the fowl, a number of fish, the frog, toad and turtle are given in Table 2. The quantity of desoxyribonucleic acid is a constant for different cells of the same animal, and the value of this constant is a characteristic of each species.

Table 2

	Desoxyribonucleic acid (mgm. × 10^{-9}) in:			
Animal	Nucleus of erythrocyte	Nucleus of hepatic cells	Sperm	Number in previous column × 2
Domestic fowl	2·34	2·39	1·26	2·52
Shad	1·97	2·01	0·91	1·82
Carp	3·49	3·33	1·64	3·3
Brown trout	5·79		2·67	5·34
Frog	15·0	15·7		
Toad	7·33		3·70	7·40
Green turtle	5·27	5·12		

Different as erythrocytes and liver cells are from each other, one point of identity is that they have the same number of chromosomes, and it is surely significant that desoxyribonucleic acid is found in the chromosomes only. Because of these considerations, and because sperm cells have one half the number of chromosomes found in somatic cells, the quantities of desoxyribonucleic acid per sperm cell were determined for various species. From the results given in Table 2, it can be seen that the quantity per sperm cell is one half that found in a somatic cell. Observations on egg nuclei show that the quantity of desoxyribonucleic acid in the egg nucleus corresponds very closely to that in the sperm. If the data given in Table 2 are considered in relation to the chromosome theory of heredity, the conclusion that follows is that desoxyribonucleic acid is part of the genic material. This does not mean, however, that the gene consists of nothing but nucleic acid.

Since the quantity of desoxyribonucleic acid per nucleus is a constant for a species, it has been determined by us for a considerable number of animals, invertebrates and vertebrates. These values are of interest from an evolutionary point of view.

Once it is known that the quantity of desoxyribonucleic acid per nucleus is the same in different cells of an organism, it becomes clear that the quantity of residual protein varies considerably. A cell with an abundant, metabolically active cytoplasm has chromosomes with a large quantity of residual protein; and a cell with scanty cytoplasm has chromosomes with but little residual protein. The residual protein of the chromosome, it would seem, is concerned with interactions between chromosome and cytoplasm. Since the needs of the cytoplasm vary in different cells, and vary in a given cell at different times, it is scarcely surprising that the residual protein is, at least in part, a variable component of the chromosome.

Table 3

Nucleus of:	Desoxyribonucleic acid in 1 nucleus × 10^{-9}	Multiple of value found in sperm
Bull sperm	2·82	
Calf thymus	7·15	2·54
Calf lymph node	7·03	2·49
Calf kidney	6·25	2·21
Beef kidney	6·81	2·41
Calf liver	6·22	2·20
Beef liver	8·4	3·0

In Table 2 no values for mammals are given. Table 3 contains some analytical values for the nuclei of cattle. It will be seen that there are some variations from the simple relationships found in other vertebrates. It is well known that polyploidy occurs in mammalian liver, but polyploidy is not the explanation of the high value found for beef liver, for in counting liver nuclei the double-size nuclei were counted separately and the necessary correction was made. It is probable that some other duplication of genic material is responsible for the analytical results given in Table 3.

Finally, it should be mentioned that Boivin[2] and his collaborators have made determinations of the quantity of desoxyribonucleic acid per nucleus in several mammals. Their work and ours have been done altogether independently of each other. A comparison of the analytical values shows that some of their results differ from ours.

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[1] Mirsky, A. E., and Ris, H., *J. Gen. Physiol.*, 31, 1, 7 (1947).

[2] Boivin, A., Vendrely, R., and Vendrely, C., *C.R. Acad. Sci., Paris*, 226, 106 (1948). Vendrely, R., and Vendrely, C., *Experientia*, 4, 434 (1948).

MODE OF PRODUCTION OF CHROMOSOME ABNORMALITIES BY THE NITROGEN MUSTARDS

THE POSSIBLE ROLE OF CROSS-LINKING

By R. J. GOLDACRE, A. LOVELESS
AND
W. C. J. ROSS
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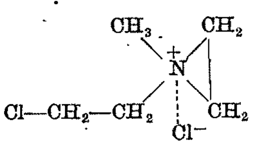
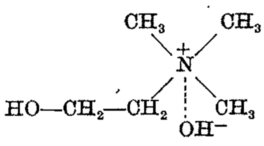
In a recent publication[1] attention was directed to the cytotoxic action of a series of halogenoalkylarylamines, of which the compound $PhN(CH_2CH_2Cl)_2$ may be taken as typical. The structural conditions requisite for activity were stated to be the presence of two halogenoalkyl groups in the molecule together with a certain minimum reactivity of the halogen, as measured by the ease of hydrolysis. In the cytological changes which these compounds produce they largely resemble their aliphatic analogues.

The action of the nitrogen mustards has been connected with their ability to pass into a cyclic ethyleneimonium ion (I)[2]. This ion presents a formal resemblance to choline (II), as pointed out by Barron, Bartlett and Miller[3], and these authors have found that the aliphatic nitrogen mustards are antagonists for choline oxidase, acetylcholine-esterase and choline-acetylase :



(I)



(II)

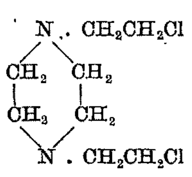
While formation of a cyclic ion may also occur in otherwise inactive compounds with only one halogenoalkyl side-chain, the presence of a second side-chain obviously permits a much closer analogy with choline, and might conceivably be significant in this way. In a recent paper[4] it is, however, shown that there is no evidence for the formation of a cyclic ion from the aromatic nitrogen mustards, while the possibility of the transitory existence of such an ion cannot, of course, be completely excluded. The evidence against the existence of a cyclic ion is, briefly, as follows : (1) the amount of halide ion liberated is at all times equal to the acidity produced, and it can be assumed that no quaternization of the nitrogen atom occurs ; (2) the instantaneous reaction with thiosulphate, which has been used as a measure of the concentration of the cyclic ion, is not observed with these compounds ; (3) although S. D. Ross has shown[5] that 1-diethylamino-2-chloropropane undergoes a rearrangement on hydrolysis which is interpreted as involving the closing of the ethyleneimonium ion followed by re-opening of the ring at a different point, the analogous aromatic compounds have not been found to undergo such a change.

It has already been suggested that the cytotoxic activity of the nitrogen mustards may be due to the alkylating effect of the halogenoalkyl group on functional groups of body constituents. Thus the active aliphatic compounds react with amino, sulphydryl, carboxyl and imidazole groups in proteins[6] and almost certainly with amino and secondary phosphoryl groups in nucleic acids, as has been found for di(chloroethyl) sulphide, one molecule of which may react with two groups[7]. Now there is considerable evidence[8,9,10] that groups such as these in the protein molecule are not always accessible, but are at some time buried within the molecule, owing to a change in the folding of the polypeptide chain, which is held by Astbury[11] and Seifriz[12] to be the basis of protoplasmic contractility in general. In particular, it is suggested that the shortening of prophase chromosomes is a continuation of the shortening by molecular folding of the chromosome's constituent fibres, which must at some stage in the resting nucleus be completely unfolded to ensure that all parts of the template contribute to re-duplication.

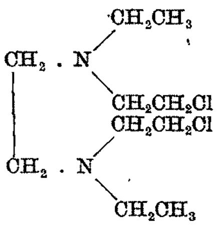
Apart from the possible implication contained in the paper by Barron *et al.*[3], no explanation has so far been given of the necessity for two halogenoalkyl groups in a single molecule. A fresh possibility is now suggested, namely, that the two groups are required to permit the molecule to react at two distinct points, lying either on a single surface or fibre or, more especially, on two contiguous fibres. Thus, when the first haloalkylamino group has become anchored to a reactive centre, the second group approaches and can react with another centre either on the same protein chain or on an adjacent one. The possibility that cross-linking may play a part in the action of mustard gas on the nucleic acids has already been considered by Elmore *et al.*[7], in an investigation which these authors believed might provide an explanation of the cytological effects of mustard gas as described by Koller[13], Robson[14] and Fell and Allsopp[15].

Of the various possibilities, cross-linkage between separate fibres is of particular interest when considered in the light of the assumption that reaction is directly with the genetic material. The latter has already been postulated in respect of chemical mutagenesis[16], while it is known that the cell is most susceptible to the effects of the mustards immediately prior to mitosis when the chromosome has just re-duplicated[17]. There is therefore at this time a system in the cell consisting of parallel identical fibres, the gene strings of the sister chromatids. Moreover, the fibres are extended in the process of re-duplication and could be, by analogy with stretched elastic polymers, at their highest energy : it is not difficult to visualize breakage of chromatids or of whole chromosomes as the direct consequence of interchromatid cross-linkage at this time (for example, fragmentation could result from tension upon the extended threads of the interphase chromosomes cross-linked so as to produce a junction stronger than the fibres themselves). Furthermore, the possible uniqueness of such a system in the cell would account for the high degree of specificity of action shown by compounds of this type. The cytological changes due to the mustards are remarkably similar to those observed after treatment by X-radiation[18], and in the latter case equally it would appear worthy of investigation whether the effects are due to cross-linkage between adjacent protein chains. Such a union could arise, for example, by the interaction of two —SH groups under the oxidative influence of X-radiation which is known to occur *in vitro*.

Consideration of the above principles has suggested that many other molecular types, containing two or more groupings capable of similar reaction with functional centres in biological systems, would be effective as cytotoxic agents. Examples are already known of active compounds in which the two requisite haloethyl groups are attached to different nitrogen atoms (for example, III, IV), and it is obvious that a great number of variants, especially involving heterocyclic types and modification of the side-chains, calls for investigation : work along these lines is proceeding, as also upon the possible antagonistic action of thiols, and will be reported later.



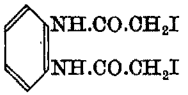
(III)



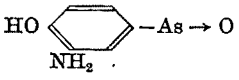
(IV)

One compound of this type upon which preliminary tests have been made is di(iodoacetyl)1 : 2-phenylenediamine (V). In tests on larvæ of *Triturus palmatus* typical radiation effects were produced in epithelial cells, fragment formation and anaphase bridges both with and without accompanying fragments being observed. The compound 'Mapharside', 3-amino-4-hydroxyphenylarsenoxide (VI), which can undergo a reversible condensation reaction with a pair of —SH groups[19], has also been tested in the same manner.

In this case the effect was to produce 'stickiness' after a few hours, and at periods of 24–48 hours after treatment, anaphase bridges with and without accompanying fragments: no fragmentation was observed except in association with bridges.



(V)



(VI)

The above suggestions as to the mechanism of action of the nitrogen mustards are put forward purely as a working hypothesis, and as possibly the simplest of a number of alternative explanations consistent with the chemical and cytological data. If, however, it is indeed true that chemical substances of these kinds produce some of their characteristic effects by reacting directly with the uncoiled resting chromosomes in the manner described, a new approach will become available to the related problems of growth inhibition, induced mutation and carcinogenesis. The connexion between these phenomena is now receiving further emphasis from the fact that tumour induction by the nitrogen mustards has recently been achieved both in the aliphatic series[20], and in the aromatic series[21]. Further reports upon this last subject will be published elsewhere.

The authors wish to express their indebtedness to Prof. A. Haddow for much advice and encouragement. The investigation upon which this discussion is based has been supported by grants made to the Chester Beatty Research Institute by the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the Division of Research Grants of the U.S. Public Health Service, and is being conducted during the tenure by one of the authors (W. C. J. R.) of a Sir Halley Stewart Fellowship, and by another (R. J. G.) of a grant from the Forsyth Bequest of the Royal Society.

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OBITUARIES

Sir Thomas Hill Easterfield, K.B.E.

Sir Thomas Hill Easterfield died at Nelson, New Zealand, on March 1, aged eighty-three, and on March 18 his ashes were scattered in a garden nook at the Cawthron Institute. He was born at Doncaster, Yorkshire, in 1866, received his primary education at the Doncaster Grammar School, and later entered the Yorkshire College (now University of Leeds), where he won a scholarship in geology and gained his first insight into chemical research, which inspired his life-work. From Leeds he proceeded to Cambridge as a foundation scholar of Clare College and gained first-class honours in the Natural Sciences Tripos; this was followed by studies at the Zurich Polytechnic School and at Würzburg. In 1888 he returned to Cambridge as a junior demonstrator in the University Chemical Laboratory, becoming a University extension lecturer in 1891, and in 1894 lecturer on pharmaceutical chemistry and chemistry of sanitary science; he was also a master at the Perse School.

In 1899 Easterfield was appointed one of the four foundation professors of the Victoria University College, Wellington, New Zealand. He held the dual chair of chemistry and physics until 1909, continuing as professor of chemistry until 1920, when he became the first director of the Cawthron Institute, Nelson, from which position he retired in 1933 after a full and active professional career. In 1938 he was honoured by knighthood in recognition of his outstanding services.

Apart from his scholastic attainments, Easterfield was a Cambridge 'miler' and took an active part in athletics. Further, as a churchman he was imbued with, and practised, the principles of Christianity which moulded his outlook and guided his footsteps. Such was this distinguished citizen who carried with him a strong sense of justice, a keenly developed flair for research, and the experienced technique of an able teacher, all of which traits left their mark on the many who had the good fortune to come under his influence.

Though Sir Thomas Easterfield will ever be remembered as an outstanding chemist who created from virtually nothing—much of the equipment was of his own making—the Department of Chemistry at Victoria College, Wellington, successfully fathering such an undertaking through all vicissitudes, it must be stressed that his scientific horizon was by no means limited by chemistry; he possessed a wide understanding of both physical and biological sciences. He held the unshakable belief that fundamental research is the prime factor in scientific advancement; he held an equally strong belief in the necessity for the application of science. It was this broad and tolerant outlook which so fitted him to direct, from their infancy, those physical and biological researches, both fundamental and technical, which, through his foresight and ability, caused the Cawthron Institute to develop so rapidly to a high standing among research organisations.

David Miller

Mr. G. M. Mathews

Gregory Macalister Mathews, author of "Birds of Australia", died at Winchester after a short illness on March 27. He was the son of R. H. Mathews, a well-known authority on Australian aborigines, and was born at Biamble, New South Wales, on September 10, 1876. After attending King's School, Parramatta, he worked on a cattle station in north Queensland and spent much of his spare time studying birds. He amassed a large collection, supplemented by many specimens received from correspondents all over Australia. For long he had planned to write a work on Australian birds, and in 1902 went to England for the purpose. At first he resided near Watford, which was convenient for the British Museum (Natural History) and Lord Rothschild's museum at Tring, where much of his work was done.

As a preliminary to his larger work, he published in the *Emu* during 1908 a "Handlist of the Birds of Australia"; then in 1912 the "Birds of Australia" began to appear, and this was finally completed in 1927 in twelve thick folio volumes. His next work was a check list of the birds of Australia and the Polynesian region, entitled "A Systema Avium Australasianarum", brought out under the auspices of the British Ornithologists' Union. Mathews had long been interested in two small islands lying between Australia and New Zealand, and in 1928 he published an account of the birds entitled "Birds of Norfolk and Lord Howe Islands", followed eight years later by a supplement.

In his earlier works he was an extreme 'splitter', and a large number of his races are not now recognized. In genera, too, he went to the same extreme, and this to a great extent was due to his confining his studies to Australian species only. In recent years, however, he greatly modified his views. He was greatly interested in nomenclature and the study of early writers on Australian birds, and his best work was done in this connexion. Between 1912 and 1927 he edited a magazine of his own, *Austral Avian Record*, which contained much useful information. But by far the most important of his publications was the "Bibliography of the Birds of Australia", which appeared in 1925 as a supplementary volume to "Birds of Australia". This is more than a bibliography, and might be considered the foundation for a history of the study of birds in Australia.

Mathews was a great collector of books and amassed the finest collection of works dealing with Australian birds. This he presented to the Australian Government in 1929, and it is now housed in the National Library in Canberra as the Mathews Ornithological Library. His collection of birds passed into the hands of the late Lord Rothschild and is now in the American Museum of Natural History in New York.

Mathews was a keen sportsman, interested in both hunting and shooting, and while engaged in his ornithological studies travelled widely, visiting most of the more important museums both in Europe and the United States. In 1924 he was vice-president of the British Ornithologists' Union and during 1936–38 was chairman of the British Ornithologists' Club. He married Marian, daughter of H. C. White, of Mudgee, New South Wales, who died in 1938, and is survived by a son.

N. B. K.

NEWS and VIEWS

Zoology at King's College, London: Dr. J. F. Danielli

Dr. Danielli, who is succeeding Prof. Mackinnon as professor of zoology in King's College, London, commenced research work in 1931 at University College under the direction of Prof. N. K. Adam. He was then working on monolayers of steroids and on cell permeability. In 1933 he went to Princeton University with a Commonwealth Foundation Fellowship and continued his work under the influence of Prof. E. N. Harvey and Prof. C. G. Conklin. He returned to University College, London, under the auspices of Sir Jack Drummond and Prof. A. V. Hill. From University College he went to Cambridge in 1938, with a Beit Memorial Medical Research Fellowship tenable in the Department of Biochemistry. Here his work was extended to the blood capillaries. He became a member of a Ministry of Supply extra-mural chemical defence research team and a fellow of St. John's College in 1942. During his later years in Cambridge he was attached to both the Departments of Zoology and Biochemistry, and his main attention was turned to cytochemistry. In 1946 he went to the laboratory of the Marine Biological Association as physiologist, and then became reader in cell physiology of the University of London at the Chester Beatty Research Institute of the Royal Cancer Hospital, and also honorary lecturer in pharmacology at University College. He plans to continue the programme developed at the Royal Cancer Hospital, and to develop research work in cytology particularly in collaboration with Prof. T. A. Bennet Clark and Prof. J. T. Randall.

Geography at Cambridge: Mr. J. A. Steers

Mr. J. A. Steers, who, in September, is to succeed Prof. F. Debenham as professor of geography in the University of Cambridge, was one of the first generation of geographers to take the newly constituted Geographical Tripos after the First World War. After a short spell of teaching at Framlingham, Mr. Steers returned to Cambridge to join the staff of the Geographical Department under Philip Lake. His College elected him to a fellowship, and before many years St. Catharine's became the first men's college to offer scholarships in geography. This led to a remarkable concentration of able geographical students in the College, which has resulted in a rapidly lengthening list of St. Catharine's geographers entering university posts—fifteen in the last ten years. In his College, Mr. Steers has served successively as dean, tutor, senior tutor, and president.

The Norfolk coast was the scene of Mr. Steers's early researches, and his frequent visits led to Norfolk replacing his own native Bedfordshire as his favourite county. These activities centred mainly on Scolt Head Island, where for many years parties of Cambridge men mixed the more sober academic pursuits with strenuous bursts of bathing and creek jumping. His taste for coastal problems led him to other parts of Britain, and culminated in two expeditions to the Great Barrier Reefs of Queensland, and one to Jamaica. A succession of papers followed promptly on various aspects of the physiography of coral reefs —the main work of writing up was sometimes accomplished on board the ship while returning to England. During the Second World War his love of the coastline led him to turn his attention to the preservation of its amenities, and his major publication, "The Coastline of England and Wales", was intended to serve the double purpose of summarizing the state of our knowledge of the coastline and of focusing attention on the need for preserving this ample but easily marred heritage. He has completed a report on the English and Welsh coasts for the Minister of Town and Country Planning, and is now engaged on a similar project for the Scottish Office. Mr. Steers's interests have by no means been confined to the coastline. His first book, "Map Projections", was a surprising and most adequate production for one who lays no claim to mathematical knowledge. "The Unstable Earth" is more representative of his real interests, which have always been close to geology; but perhaps "Scolt Head Island" expresses most nearly his approach to problems, in that it brings together the work of specialists on the various field studies in the elucidation of one specific region.

Hosiery Research Council: Dr. D. Starkie

Dr. David Starkie has been appointed director of research by the Hosiery Research Council. The appointment is one of the most important preliminary steps yet taken in the establishment of a research organisation for the hosiery industry. Dr. Starkie, who is forty-four, was educated at Staveley Grammar School and the University of Sheffield, and obtained a degree in physics, with first-class honours, in 1925. He was awarded his M.Sc. in 1926 and Ph.D. in 1927 as a result of work on the band spectra of the alkali compounds. After leaving the University, Dr. Starkie lectured and carried out research on the physical properties of glass. He spent two years on research with the Metropolitan-Vickers Electrical Co., Ltd., and then became chief physicist at Messrs. A. Jobling and Co., Ltd., glass manufacturers. In 1939 Dr. Starkie was appointed head of the physics research department of the Plastics Section of Imperial Chemical Industries. Much of his time was devoted to the investigation of the properties of synthetic yarns and fibres, and he worked in close collaboration with a special fibres development department formed to develop the use of synthetic fibres in the textile industry. When it was decided to create an optical development department in 1944, Dr. Starkie was placed in charge of its formation, and the results of his work have had important effects in the optical field. Dr. Starkie is a member of a number of scientific societies and service committees and is also on the Council of the British Scientific Instrument Research Association. He will be responsible for the plan and organisation of the new Hosiery and Allied Trades Research Association now being formed. The Hosiery Research Council, which has done the preliminary work, already possesses premises equipped for research at Thorneywood House, Nottingham, where there is the nucleus of a trained staff.

Rumford Medals: Dr. I. S. Bowen

The Rumford Medals for 1949 of the American Academy of Arts and Sciences, given for the most important discoveries in the fields of heat and light, have been awarded to Ira S. Bowen, director of the Mount Wilson and Palomar Observatories in California. It was Bowen's early laboratory study of high-excitation spectra which laid the foundations for his brilliant work on the identification of the 'nebulium' lines in the spectra of galactic nebulæ as forbidden transitions in doubly ionized oxygen. Later, his analysis of the spectra of planetary nebulæ brought to light the unexpectedly high cosmic abundance of the inert gases. The puzzle of the selective excitation of certain permitted lines in nebular spectra was explained by him in a completely satisfactory way in terms of close chance coincidences between the wave-lengths of emission lines in the inaccessible ultra-violet. Dr. Bowen is well known also as an optical designer. Perhaps the most useful device associated with his name is the 'image slicer', by which the starlight that would otherwise be wasted on the slit-jaws of an astronomical spectrograph is directed into the instrument, thus greatly increasing its effective speed. He is now in charge of the installation of the new 200-in. reflector at Mount Palomar, and is credited with a number of devices used in the optical tests. His many friends look forward with confidence to the successful initiation of the new telescope under his direction.

The Palæobotanical Society and Institute of Palæobotany, Lucknow

On April 3, the Hon. Pandit Nehru, Prime Minister of India and Minister for Scientific Research, laid the foundation stone of the newly formed Institute of Palæobotany in Lucknow. This Institute has come about as the result of a resolution passed on September 10, 1946, by the governing body of the Palæobotanical Society which had just previously been founded. The president of the Society is Mrs. Savitri (Birbal) Sahni, and the secretary, Prof. Birbal Sahni, professor of botany in the University of Lucknow.

Both Society and Institute have clearly come into being as a result of the enthusiasm of Prof. Sahni, who himself is one of the world's leading palæobotanists, and the keen interest of his wife. On the schedule of the Palæobotanical Society are Prof. Sahni's collections of scientific literature and fossil specimens; funds up to Rs. 100,000 given by Prof. and Mrs. Sahni for the building of the Institute; a perpetual endowment of Rs. 1,000 in 3½ per cent Government paper, presented by Pandit L. D. Pant for the Chandra Datt Pant Commemoration; two scholarships, furniture and laboratory equipment given by the Burmah Oil Company. It is also interesting to note that after the death of Prof. and Mrs. Sahni, all their assets are to go to the Society and Institute. Pending the completion of its own building, the work of the new Institute of Palæobotany is being carried out in a building (given to the Society by the Government of the United Provinces) by the director (Prof. B. Sahni), assistant director (S. R. Narayan Rao), curator (J. Hsü), research fellow (R. V. Sitholey), research assistants (R. N. Lakhanpol and D. C. Bhardwaj) and registrar (B. R. Agarwala). K. R. Surange has also recently joined the staff.

Commonwealth Scientific and Industrial Research Organisation, Australia

The Australian Government in March repealed the Science and Industry Research Act of the Bruce-Page Government of 1926, replacing it and its subsequent minor amendments by a single Act modifying several of the main features of the original legislation. From the Council for Scientific and Industrial Research, which has functioned for twenty-three years, all former powers and functions have been taken away, and it becomes for the future merely advisory. A new body has been set up under the title Commonwealth Scientific and Industrial Research Organisation. It consists of an Executive of five members and of the officers comprising the staff. The Executive is the governing body. Its members will be appointed by the Governor-General, and at least three of them are to possess scientific qualifications. The chairman and two others will devote the whole of their time to the duties of office. Whereas the former Council carried sole responsibility for the scientific programme placed before the Government, provision is now made for political initiation of work, it being the duty of the Organisation to exercise its powers and functions in relation to any matter referred to it by its minister. In the important matter of staff, while the Executive may appoint such officers and employ such temporary or casual employees as it thinks necessary for the purposes of the Act, it is in each case subject to the specific direction that "the selection of persons . . . shall be made in accordance with such requirements as the Public Service Board determines". So, too, terms and conditions are in all cases "subject to the approval of the Public Service Board". Also, the maximum number of officers and employees whose duties are primarily of an administrative or clerical nature is similarly subject to the Board's approval. Under the earlier Act, the Council and minister settled these matters, independently of the Public Service Board. A somewhat cryptic clause towards the end of the Act runs : "A member of the Executive, a member of the Advisory Council, a member of a State Committee, an officer or an employee shall not, except in the course of his duty as such a member, officer or employee or with the approval of the Executive, disclose any information concerning the work of the Organisation or the contents of any document in the possession of the Organisation. Penalty : Imprisonment for two years." The opportunity has been taken also to effect certain minor changes which experience has shown to be desirable ; but it is difficult at this stage to predict just how the new legislation as a whole will affect established scientific activities. The sequel need not be unsatisfactory; but it is known that in some quarters the position is regarded with a measure of anxiety.

Progress in Education

IN his presidential address to the National Union of Teachers at Margate on April 16, Mr. I. Gwynne Rees, of Port Talbot, outlined the extent to which the 1944 Education Act has already been implemented. Two years ago, at a time of unprecedented difficulties, school life for every pupil in Britain was extended to the age of fifteen. The number of teachers in primary and secondary schools is now 10 per cent greater than before the War, while the average number of pupils per teacher in the primary and secondary schools has been reduced by about 6 per cent ; in the primary school, however, the average class still remains nearly 50 per cent larger than in the secondary school. These reforms, said Mr. Rees, have been made possible by the rapid increase in the supply of well-qualified teachers, provision having already been made for the training of 66 per cent more students in the permanent colleges and 44 per cent more in the universities than before the War. The other major reform necessary for the reduction in the size of classes is, he said, the provision of sufficient classrooms. In 1948 work in progress involved an ultimate capital expenditure of £23,000,000, and in 1949 the figure would be £55,000,000. There has also been remarkable progress in the facilities for higher education. The toll-gate of school fees has been removed, and State scholarships and local education authority awards for further education have doubled in number since 1939. In the earlier stages of education, particular concern is being felt for the infant and junior schools, where the handicapping of the less gifted begins through lack of suitable equipment and through classes of forty, fifty and even sixty children. This seventy-fourth Conference of the National Union of Teachers was distinguished, for the first time, by the presence of the Prime Minister. In an inspiring address, Mr. Attlee declared that the prime duty of all teachers is to train their pupils to become good citizens of a democratic society.

ISI Bulletin

A NEW quarterly journal, *ISI Bulletin*, has been issued by the Indian Standards Institution, *P* Block, Raisina Road, New Delhi. The price is 2*s*., and the first number contains thirty-six pages. The Indian Standards Institution was founded in 1947, primarily as an industrial organisation, but with Government support. The president is Dr. S. P. Mookerjee, Minister for Industry and Supply, and its director, Dr. Lal C. Verman. It has set up four executive committees for agricultural products, documentation, quality control and industrial statistics, and weights and measures, together with engineering, textile and chemical division councils, sponsoring a total of 118 committees and sub-committees. Draft standards on textile shrinkage tests and fireclay refractories have already been published. Apart from much detailed information the *Bulletin* contains the president's address to the general council and three very interesting general articles. The first of these, on the "Standard Atmosphere for Testing", compares average atmospheric conditions in India with those in other parts of the world and makes recommendations, which the Indian delegation was successful in getting accepted by the International Standards Organisation, for alternative 'standard atmospheres' to be adopted for use in industrial testing laboratories in tropical and temperate climates respectively. The second paper, on "Quality Control", is mainly a record of various conferences and papers relating to this subject, largely directed to its applications to the textile industry. The last paper deals with "Weights and Measures". It includes a brief summary of the past and present position in India, and puts forward a proposal for the adoption of the metric system with Indian names for the units, and a series of Indian prefixes and affixes to denote the successive powers (multiples and sub-multiples respectively) of 10. The *Bulletin* gives an impression of vitality which augurs well for the future success of the new organisation.

Scientific Information in India

COMMENTING on the Royal Society's Conference on Scientific Information Services in London last year (see *Nature*, August 21, 1948, p. 279), the *Journal of Scientific and Industrial Research* (*India*) (Nos. 9 and 10, pp. 387, 435 ; 1948) emphasizes the importance of such aids to research and the urgency of evolving a satisfactory system in India. It accepts the view that the primary requirement is a central organisation, maintaining liaison with similar organisations in other countries and directed by a man of science with width rather than depth of interests, who is able to perceive and satisfy the bibliographical needs of a large clientele. The needs of a really adequate information centre, for assembling scientific and technical information from India and elsewhere and for distributing such information, require consideration both from the point of view of organisation and material. The research aspect of information and intelligence work does not appear to have been recognized sufficiently in India; and the editor calls for a lead from the Indian Department of Scientific and Industrial Research towards the organisation of an efficient service on lines emphasized at the Royal Society Conference and already adopted not only by the Department of Scientific and Industrial Research in London but also in Australia, New Zealand and Canada, and by the National Research Council of the United States.

German Wool Industry

THE Wool Industries Research Association has recently prepared "B.I.O.S. Overall Report No. 9: The German Wool Industry during the period 1939–1945" (pp. 56. London: H.M. Stationery Office, 1948. 1*s*. net). The report suggests that in respect of blending, carding, spinning, weaving, dyeing, finishing, shoddy and mungo manufacture, machinery design, operation and production there is little that the British industry can learn from its German counterpart. Much of the latter's woollen yarn industry was judged to be obsolete by American standards with, on the whole, low productivity, and, though allowance must be made for the quality of the raw material in use, the quality of work now being done was said to be poor by most of the investigators. Output was generally higher than with average Yorkshire setts; but the standard of carding was lower. The modified Duhamel scouring process is economical in both alkali and soap, and merits careful examination. Much attention has been devoted by the Germans to by-product recovery, although there is nothing new in principle in the processes used. The exact efficiency of the German worsted industry is difficult to assess; but it would appear that while, compared with Britain, the German industry has the advantage of better buildings, facilities and general amenities, German technicians have made no great mechanical or processing advances. Little advance in research was recorded in the war years, although some work on improving the sensitivity of wool to alkali, increasing the fastness of dyes, on moth-proofing, on low-temperature dyeing and the dyeing behaviour of the Palatine Fast dyes is noted. A bibliography of the reports and documents on which the report is based is appended.

Management Training at Staff College

IN the paper "The Staff College in Training for Management", Mr. N. F. Hall, principal of the Administrative Staff College, reviews his experimental work during the last two years in bringing the College into operation, and this paper has now been issued by the British Institute of Management, together with the introductory remarks of Sir Charles Renold and a report of the discussion, as the first report in the *Winter Proceedings* series of the Institute. Mr. Hall stresses that the task is to make a co-ordinated group out of individual specialists and to increase the capacity of those trained in administration and in different fields of technology to work together. The bulk of the work of each course is carried out by the discussion method, and this ensures that the basic principles of administration and their practical application will be examined. The study of biography has been introduced to provide opportunities for discussing the importance of personality and character in administration and to liberalize a concentrated practical course. While emphasizing the value of a well-balanced admixture of practical experience among the members of each session, Mr. Hall recognizes that the size of any mixed staff college must be small, both because of the importance of all members getting to know each other and because of the limits dictated by the group-discussion method used. Accordingly, great care should be exercised to avoid building up a privileged caste of those who have passed through the Staff College, from which there cannot at present be an annual output of more than about two hundred. As to the length of the course, Mr. Hall thinks it should remain at about three months or else be increased to a year; and for the present he thinks that three months represents a reasonable working compromise.

Fouad I University, Cairo: Faculty of Science

THE annual report, 1946–47, of the faculty of science, Fouad I University of Cairo, gives a brief description of the research activities, including particulars of papers published and some notes on researches in progress. In the Department of Pure Mathematics work is continuing on the distribution of cranial curves and on mortality tables, while in that of Applied Mathematics work is in progress on the unified field theory, the velocity potential of the fluid motion induced by the motion of a cylinder in an infinite mass of compressible fluid, and the effect of polarization on secondary scattered light. In the Department of Physics the subjects under investigation include electron polarization, viscosity of gases, electron diffraction by liquid films, the measurement of atmospheric turbulence, supersonic diffraction through slits and the viscosity of plastics. In the Department of Zoology the study of some biological and morphological aspects of lamellibranchs, the fauna of Egypt, the excretion of reptiles, and the embryology of scorpions is continuing, and a study has commenced of the anatomy, histology and physiology of the digestive system of some Egyptian Lacertilia. In the Department of Entomology work continued on some of the Bombyliidæ of Egypt, and on the biology and ecology of various dung insects.

The Country Journal

THE second number of the recently launched *The Country Journal* contains a collection of articles which should satisfy the varied tastes of those who live and work in the countryside and the unfortunate town-dwellers who wish to do so. There are articles for the farmer, the gardener, the botanist, the ornithologist, the bee-keeper and the member of the women's institute; while in an admirable survey many of the recent books on natural history and rural subjects are classified for the convenience of several types of readers. In the present number of the journal two articles of absorbing interest are those by Frank Illingworth on the countryman's games and Trevor Holloway on curious country place-names. Particulars of the new journal may be obtained from the Worcester Press, Worcester.

Virus Diseases of Lettuce

DANDELION yellow mosaic virus was first reported by B. Kassanis in 1944. He then showed that the disease could also affect lettuce. More recently (*Ann. App. Biol.*, 34, No. 3, 412–421; Sept. 1947) the same author has described the symptoms and transmission of dandelion yellow mosaic and of lettuce mosaic. He also reports the isolation of cucumber mosaic from naturally infected lettuce. Lettuce is more susceptible to dandelion yellow mosaic than is its name host. The aphid *Myzus persicæ* transmits lettuce mosaic, but not dandelion yellow mosaic, which is, however, spread by *Myzus ornatus*, *M. ascalonicus* and *Aulacorthum solani*. The common lettuce aphid, *Nasonovia ribicola*, rather perversely transmitted neither virus. Lettuce mosaic is found in most samples of commercial seed; but dandelion yellow mosaic is not seed-borne.

Frank B. Jewett Fellowships: New Awards

THE American Telephone and Telegraph Co. has awarded the Frank B. Jewett Fellowships for 1949–50 to the following: Dr. Harish-Chandra, a graduate in mathematics and theoretical physics of the University of Allahabad, the Indian Institute of Science in Bangalore and the University of Cambridge, who has done considerable research on the theory of elementary particles and is at present working on the theory of Lie algebras at the Institute for Advanced Study, Princeton; Dr. James A. Jenkins, a graduate in mathematics and physics of the University of Toronto and Harvard University, who is engaged in research relating to topological mapping problems at Harvard University; Dr. Robert Karplus, a graduate in chemical physics of Harvard University, who is engaged in nuclear research at the Institute for Advanced Study, Princeton; Dr. Joaquin Mazdak Luttinger, a graduate in physics of Brown University and the Massachusetts Institute of Technology, who has been studying at the Physikalisches Institut, Zurich, and will continue his research there on the theory of the superconductive state; Dr. David Emerson Mann, a graduate in physics and chemistry of the City College of New York and of the University of Chicago, who is engaged in research in quantum mechanics at the University of Minnesota; Dr. Harvey Winston, a graduate in chemistry of Columbia College, who will undertake research in crystallography. These fellowships are designed to stimulate and assist post-doctorate research in the fundamental physical sciences and are awarded on the recommendation of a committee of seven from the Bell Telephone Laboratories. The awards carry a grant of 3,000 dollars to the recipient and 1,500 dollars to the institution at which the research is done.

Textile Institute: Awards

DR. D. A. CLIBBENS, of the British Cotton Industry Research Association, has been made an honorary fellow of the Textile Institute, in recognition of his work on the chemistry of cellulose and the development of analytical and testing methods for the control of bleaching, mercerizing and dyeing. This distinction has only been conferred on eight previous occasions. Dr. S. A. Shorter, formerly of the British Cotton Industry Research Association, has been awarded the Warner Memorial Medal, in recognition of original investigation, the results of which have been published in the *Journal* of the Institute. The Institute Medal, for distinguished services to the textile industry in general and to the Institute in particular, has been awarded to Messrs. A. W. Bayes and Harold Ashton, and the Service Medal, for valuable services rendered to the Institute, to Messrs. H. C. Barnes and S. Kershaw.

Symposium on Engineering Structures at Bristol

THE Colston Research Society has arranged with the University of Bristol a series of symposia, to be held annually, on selected research topics of current importance. The first of these, on cosmic rays, took place last September, and the second, on engineering structures, will be held during September 19–23. At this symposium the papers read will deal mainly with non-linear aspects of the behaviour of engineering structures; but some more general papers reviewing research work on various kinds of engineering structures will be included. A number of men of science, well known in this field, have been invited, and the symposium will be open to all research workers and students connected with this subject. However, the numbers will be limited to eighty, and requests for admission should be sent, before July 1, to Prof. A. G. Pugsley, Merchant Venturers' Technical College, Bristol 1.

The Night Sky in May

FULL moon occurs on May 12d. 12h. 51m., U.T., and new moon on May 27d. 22h. 24m. The following conjunctions with the moon take place: May 6d. 20h., Saturn 3° S.; May 17d. 14h., Jupiter 5° N.; May 26d. 16h., Mars 2° S.; May 27d. 12h., Mercury 0·8° S. Mercury is an evening star, setting at 21h. 10m., 21h. 43m. and 20h. 16m., at the beginning, middle and end of the month, respectively; but in the latter case it is too close to the sun to be observed. The planet attains its greatest eastern elongation on May 10. Venus is an evening star and can be seen for a short time in the western sky after the middle of the month, setting 35 min. and nearly an hour after the sun on May 15 and 31, respectively. Mars is a morning star but rises too soon before the sun for favourable observation. Jupiter rises at 1h. 30m., 0h. 35m. and 23h. 33m., on May 1, 15 and 31, respectively, and is visible for a few hours before sunrise. The planet is stationary on May 20. Saturn is visible until after midnight, setting at 2h. 40m., 1h. 45m. and 0h. 45m., at the beginning, middle and end of the month, respectively, and is stationary on May 1. Only one occultation of stars brighter than magnitude 6 occurs, λ Canc. disappearing at 21h. 30·6m. on May 4.

Announcements

THE L. T. Hobhouse Memorial Trust Lecture will be delivered at King's College, University of London, on May 12, at 5.30 p.m., by Prof. V. Gordon Childe, professor of prehistoric European archæology in the University of London, who will speak on "Social Worlds of Knowledge". Admission will be free, without ticket.

A RESEARCH scholarship of the value of £400 per annum and tenable for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Action of Nitrogen Trichloride on Proteins: Progress in the Isolation of the Toxic Factor

PREVIOUS work by Mellanby[1] and Moran[2] has shown that treatment of many proteins with 'Agene' (nitrogen trichloride) produces material which when fed to dogs causes hysteria and epileptiform fits. Radomski, Woodward and Lehman[3] found that rabbits are also sensitive to nitrogen trichloride-treated proteins, and we have found it convenient to employ these animals in preference to dogs since they obviously have considerable advantages in the routine semi-quantitative toxicity assays involved in the course of purification experiments.

We have employed as starting material finely powdered zein treated with nitrogen trichloride at the level of 5·5 mgm./gm. by absorption from a mixture of nitrogen trichloride vapour and chlorine diluted with moist air. 5 gm. of this treated zein is sufficient to produce running fits and convulsions in a 1-kilo rabbit within forty-eight hours. The corresponding amount for a dog is about 25 gm.

The first important point in the purification process is that toxic material can be recovered from treated zein after hydrolysis for three hours in boiling hydrochloric acid (initially 8 *N*). However, it is more convenient, in order to reduce the quantities of material to be processed, first to concentrate the toxic factor by digestion of treated zein with pancreatin. Dialysis through 'Cellophane' separates the toxic factor in the dialysate, which is then extracted successively with water-saturated *n*-butanol at 80° and then with phenol in the cold. The toxic factor remains in the aqueous phase after butanol extraction and is afterwards recovered from the phenol-rich phase. We have made numerous attempts to purify further the phenol-soluble fraction by means of partition chromatography. This fraction is thought to be largely a complex mixture of amino-acids and peptides, and using *n*-butanol as developing solvent on columns of silica gel or starch, the toxic factor is concentrated in a stationary or very slowly moving band, while fast-moving bands can be eluted. Using phenol on columns of silica gel, the toxic factor moves in the fastest-running band. However, considerable losses of toxicity have invariably been encountered on columns of this type, and accordingly it was decided to hydrolyse with acid before attempting any further purification.

Phenol-soluble material is hydrolysed by boiling under reflux for three hours with hydrochloric acid (initially 8 *N*) (the bulk of excess hydrochloric acid removed by repeated evaporation *in vacuo* and the residue redissolved in water), again repeatedly extracted with hot butanol and decolorized with charcoal activated with acetic acid according to the method of Tiselius[4].

The behaviour of this material has been examined in columns of silica gel using phenol as solvent, on anionic resin exchange columns, when subjected to electrodialysis and on fractional precipitation with acetone. These methods have been used individually and in combination; at all stages, fractions have been examined by means of paper chromatography.

A sequence which has been found consistently reproducible is as follows. The decolorized acid solution is brought to 95 per cent acetone concentration, when the toxic factor is distributed between the gummy precipitate and the soluble fraction. The precipitate, redissolved in water, is electrodialysed in a three-compartment cell of the type used by Albanese[5], and the material from the middle compartment is then applied to a resin exchange column ('Zeo-Karb' 215). On elution with ammonia (0·15 *N*) the amino-acids appear in the effluent in the same order as that described by Partridge[6], the toxic factor being eluted in a broad band following proline and extending to the point of the ammonia 'break through'.

When examined on paper chromatograms, the material of the toxic band is found to contain several ninhydrin-reacting substances; namely, proline, a substance *A* (probably methionine) with an R_F value of 0·75, and unidentified substances giving a group of purple spots of R_F values in the range 0·1–0·3 (Whatman No. 4 paper run with phenol). By precipitation with acetone it is possible to remove this last material and still retain toxicity, thus showing that these substances of low R_F value are impurities and cannot be identified with the toxic factor; separate feeding tests confirm that they are non-toxic. Again, when the toxic band is treated by partition chromatography on columns of silica gel, using phenol as solvent, toxic material is obtained both from the fraction first eluted (containing proline and *A*) and also from the slower-moving fraction containing the substances of lower R_F. The inference, therefore, is that the toxic factor cannot be related to any known ninhydrin spot on paper chromatograms. Evidence in support of this, but admittedly not conclusive, is found in the fact that untreated zein degraded and fractionated by exactly the same procedure as above is entirely non-toxic when fed to rabbits, and yet gives a pattern of ninhydrin spots identical with that given by toxic material. Another interesting fact is that when our most concentrated toxic material is hydrolysed by acid under conditions which are normally considered to give complete hydrolysis of protein and peptides, no new ninhydrin-reacting substances are revealed. This would suggest that the toxic factor is not a peptide, unless it is present in amount below the sensitivity of the ninhydrin test.

A rough measure of the progress of purification by the various steps is shown in the accompanying table. The toxic dose refers to the dry weight of the material which will produce convulsive fits in a rabbit of weight approximately one kilo within forty-eight hours.

Step	Fraction	Toxic dose
	Treated zein	5 gm.
Pancreatin digestion	dialysate	1·5 ,,
Butanol extraction	aqueous phase	1·0 ,,
Phenol extraction	phenol phase	0·6 ,,
Acid hydrolysis and butanol extraction	aqueous phase	0·3 ,,
Charcoal and acetone precipitation	precipitate	0·15 ,,
Electrodialysis	middle compartment	30 mgm.
Ion-exchange displacement	end fraction	4 ,,
Acetone precipitation and silica gel	—	2 ,,

The toxicity of our most concentrated material represents, therefore, a 2,500-fold increase on that of the original treated zein.

It should be mentioned that both stages of the last step, precipitation with acetone and recovery from a silica gel column, are not entirely satisfactory as a method of purification, since they are erratic and occasionally involve loss of toxic material. The silica gel column is, however, consistent and reproducible with respect to the known ninhydrin reactants.

Complete isolation and characterization of the toxic factor require operations on a scale larger than has been possible for us hitherto, but these are now in hand.

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A Morphological Distinction between Neurones of the Male and Female, and the Behaviour of the Nucleolar Satellite during Accelerated Nucleoprotein Synthesis

GENETICISTS have long emphasized that 'maleness' and 'femaleness', so far as chromosome content is concerned, are projected from the fertilized ovum into the morphologically and functionally specialized somatic cells. It appears not to be generally known, however, that the sex of a somatic cell as highly differentiated as a neurone may be detected with no more elaborate equipment than a compound microscope following staining of the tissue by the routine Nissl method.

The observations to be recorded here apply to the cat primarily, since the cat is used routinely in this laboratory for investigations in experimental neurocytology. The nuclei of nerve cells contain a prominent nucleolus which stains readily with such basic dyes as cresyl violet and thionin. The difference in nuclear structure between neurones of adult male and female cats rests on the degree of development of a second body, which is much smaller than the nucleolus. The latter body is more or less intimately associated with the nucleolus and, like the latter, stains well with basic dyes. It has been described by many authors under various names. The term 'nucleolar satellite' will be used in this report, in the hope that students of chromosome morphology will not object too strenuously to the use of the word 'satellite' in this connexion.

Typically, nerve cells of mature *female* cats contain a well-developed nucleolar satellite which is located, as a rule, immediately adjacent to the nucleolus (Fig. 1). A single satellite is usually present; but two may be encountered. The satellite, if more deeply stained than the nucleolus, may be seen in all nerve cells which are sufficiently large to have a prominent nucleolus. More often, the intensity of staining of the nucleolus and its satellite is similar. Under these conditions, the satellite is seen in approximately 30–40 per cent of cells, being invisible when eclipsed by the nucleolus.

As a rule, nerve cells of mature *male* cats (Fig. 2) contain a poorly developed nucleolar satellite, seen only infrequently. When visible, it is situated adjacent to the nucleolus and is near the limit of resolution with an oil-immersion objective.

In a small proportion of animals of both sexes, nucleolar satellites of intermediate size are present. These exceptional cases raise several interesting questions which are now under investigation.

The morphological distinction, therefore, between neurones of the mature male and female cat is so

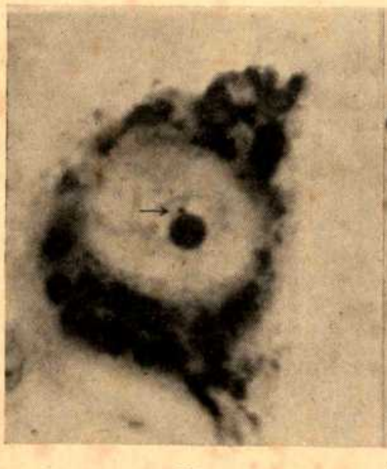

Fig. 1

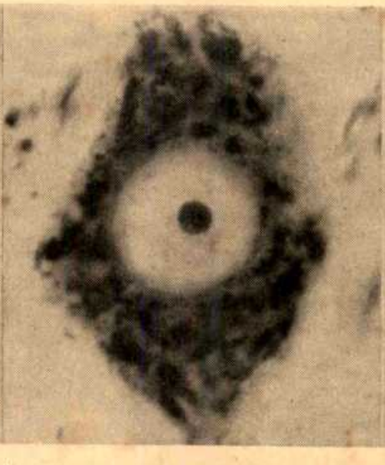

Fig. 2

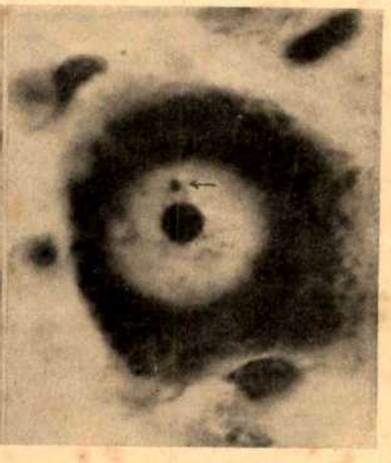

Fig. 3

Fig. 1. Normal motor neurone from the hypoglossal nucleus of a mature female cat showing the usual morphology of the nucleolar satellite (indicated by arrow) in the female. Cresyl violet stain, × 1,400

Fig. 2. Motor neurone from the hypoglossal nucleus of a mature male cat. The nucleolar satellite is absent, the typical condition in the mature male. Cresyl violet stain, × 1,400

Fig. 3. Motor neurone from the hypoglossal nucleus of a mature female cat 108 hours following electrical stimulation of the corresponding hypoglossal nerve for a period of 8 hours. Associated with intense synthesis of cytoplasmic ribose nucleoproteins, the nucleolar satellite (indicated by arrow) tends to move away from the nucleolus. Cresyl violet stain, × 1,400

clear that sections from the brain, spinal cord or sympathetic ganglia of animals of both sexes may be readily sorted into two groups without prior knowledge of the sex, with only an occasional section remaining in which the distinctive morphological feature is of an intermediate character.

That there should be a morphological difference in the inter-mitotic nucleus of mature, differentiated cells, according to their sex, is not surprising in view of what is known concerning the relation of the nucleolus to the chromosomes. The nucleolar chromosomes are frequently the sex chromosomes[1]. One may postulate that such is the case in the cat. The nucleolar satellite may be derived from the heterochromatin of the sex chromosomes. Further, the cells of the female cat, because of the duplicated X-chromosomes, may be endowed with a greater quantity of nucleolar associated heterochromatin than are the cells of the male cat. Caspersson and Schultz[2] noted a difference in the absorption curves obtained with ultra-violet light, indicating a difference in nucleoprotein content, in cells of male and female *Drosophila*. These comments suggest the importance of taking the sex into consideration in cytochemical studies of nucleoprotein metabolism.

A preliminary examination of sympathetic ganglia of human males and females indicates that a similar sex difference in nuclear morphology exists in the human. Whether or not such sex differences in nuclear structure will be found in a given species would probably be determined, in part, by the relationship of the nucleolus to the sex chromosomes and by the disparity in size and composition between the X- and Y-chromosomes. It is probable that somatic cells of various tissue, characterized by large nucleoli, will display similar distinctive nuclear differences according to the sex.

We wish to emphasize that these observations apply to mature animals. The influence of the age factor and other aspects of the nucleolar satellite under normal and experimental conditions will be published in later reports.

It is of interest to experimental neurocytologists that the position of the satellite relative to the nucleolus is a useful aid in assessing the physiological state of the cell. In a series of experiments, to be reported in detail elsewhere, depletion of the Nissl material of motor neurones was produced by prolonged electrical stimulation of the hypoglossal nerve. The nucleolus enlarges during the recovery phase, coincident with the re-appearance of abundant Nissl material in the cytoplasm. This observation is in agreement with the views of Caspersson and his co-workers, who regard the nucleolus and the nucleolar associated chromatin as instrumental in the synthesis of ribose nucleoprotein, an important component of the Nissl substance (see Hydén[3] for references). It is of particular interest in the present connexion that the satellite moves away from the nucleolus during the period of intense ribose nucleoprotein synthesis (Fig. 3). The satellite may, in these circumstances, lie in contact with the nuclear membrane. The movement of the nucleolar satellite may be passive, resulting from the outpouring of materials (nucleotides or nucleic acids ?) from the region of the nucleolus. On the other hand, complex factors, such as forces of an electrical nature, may be at work. In any case, the position of the satellite is another item for observation, in addition to the appearance of the Nissl substance, in attempting to assess the physiological state of the neurone under experimental conditions. This criterion may be applied to best advantage, of course, only to the cells of female cats. The nucleolar satellite is occasionally found free in the nucleoplasm in control cells. This is regarded as a further indication of the variation in the physiological state of members of a nerve-cell population under normal conditions.

It is hoped that this brief preliminary report may encourage closer attention to the nucleolar satellite in the abundant material available to laboratories of neuropathology in which the Nissl method is constantly in use as a routine staining technique. The possibility that fundamental alterations in the nucleolar associated chromatin may have an important bearing on malignancy gives added interest to these observations.

These observations were made in the course of experiments on the effect of activity on the neurone being done in this laboratory for the Institute of Aviation Medicine, Royal Canadian Air Force. The senior author wishes to thank various members of the staffs of the Department of Neuropathology, University of Toronto, and of the Montreal Neurological Institute, for very helpful discussions.

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Effect of a South African Native Diet upon Rats

YOUNG rats of the Wistar Institute strain aged five to six weeks and weighing 70–100 gm. were fed on the Gillman diet[1]. This consisted of liberal quantities of a thick mealie-meal porridge and fermented cow's milk. Animals were killed after they had been on this diet for four and a half and six months. All, except two in the latter group, showed an abnormal bromsulphalein retention in the serum; but the serum proteins, thymol turbidity, thymol flocculation and colloidal gold tests were within normal limits.

The following organs were examined histologically: liver, kidney, spleen, upper incisor teeth and periodontal tissues. The lower ends of the radii and ulnæ and the upper ends of the tibiæ were examined by the line test[2]. Microscopy of the livers revealed relatively little fatty change, but practically complete absence of glycogen in all except the two rats, which showed a normal bromsulphalein excretion. In these two rats the amount of glycogen present in the liver was normal. The kidneys and spleens of all animals showed no abnormal histological changes. Interesting pathological changes were, however, found in the incisor teeth and periodontal tissues, which are best described under three heads.

(1) The animals were suffering from a sub-acute vitamin A deficiency, which was not severe after four and a half months, but was much more marked after six months. This was seen in the teeth of the younger rats as a lack of regression of the odontoblasts, which

became included in the dentin, especially on the lingual side, the predentin eventually disappearing. This phenomenon was seen on both sides of the teeth in the older rats; in addition, these teeth showed an atrophy of the odontoblasts on the lingual side at the formative end and a subnormal production of dentin, together with over-production of dentin on the labial side; apposition instead of resorption was found on the periodontal side of the premaxillary labial alveolar bone, which is also typical of vitamin A deficiency[3]. The only microscopic change characteristic of vitamin A deficiency which was not present was keratinization of the naso-lacrimal duct epithelium; but in long-standing sub-acute vitamin A deficiency this sometimes does not occur. In some of the older rats a chronic infection was present, as shown by an invasion of small round cells, plasma cells, eosinophils, macrophages, etc., in the mucous glands at the formative end of the tooth and elsewhere. The lingual dentin at the incisal end of the tooth of one of the older rats contained Gram-positive and -negative cocci, and the underlying pulp had an inflammatory reaction. The organisms were found in the dentin tubules and in the cavities containing the vascular and cellular inclusions. Externally, the animals showed no signs of vitamin A deficiency, and the teeth had kept their orange pigment.

(2) A rachitic condition was present, seen as an extreme widening of the predentin on both sides of the tooth. In the older animals some healing had occurred. The epiphyseal cartilages of the long bones were not wider than usual, and the fundic bone of the alveolus was also normal, so that it would appear that this rickets was of the low-calcium type. This surmise is supported by the fact that the calculated calcium and phosphorus contents of the diet were 0·057 and 0·16 per cent respectively, with a Ca : P ratio of 0·36.

(3) In all rats, but especially in the older ones, the enamel organ and particularly the ameloblasts showed early and abnormal atrophy. This was accompanied by the presence of many macrophages in the labial alveolar periosteum, especially towards the incisal end of the tooth. In the younger rats, these cells contained a few granules; but in the older animals they were laden with many conspicuous granules. In the older rats, the pigment layer of the enamel persisted, after removal of the rest of the enamel during the histological decalcification process. It was attached to the enamel organ, from the level of the granule-containing ameloblasts up to the alveolar crest, and the granule-containing ameloblasts were usually conspicuous. Tests for iron were positive for this pigmented layer, for the granules in the macrophages and for those in the ameloblasts. It seems almost certain that the granules in the macrophages were the same in composition as the pigmented enamel. Chase[4] has described an invasion of macrophages in conditions where the enamel organ was degenerative, and we have also seen this in other specimens where the enamel organ was atrophying from a variety of causes, but never so markedly as here.

From the evidence of the teeth it seems that a multiple deficiency was present. It is possible that the vitamin A or vitamin A precursors present in the two constituents of the diet were partially destroyed by oxidative processes when the ingredients were mixed together, especially when fermented milk was used. Györgyi[5] has reported that vitamin E prevents the hepatic injury caused by certain deficient diets, and vitamin E is known to afford protection to carotene[6]. However, no correlation at all was found between the tooth changes and the alterations in the bromsulphalein serum retentions in the present experiments; this does not support the proposition that both are caused by the same deficiency. The rachitic condition is explained by the very low calcium and phosphate contents of the diet and by the abnormally low Ca : P ratio. The changes in the pigment layer of the enamel have not been described before, and are being further investigated.

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A New Mutant in the Progeny of Mice Treated with Nitrogen Mustard

The ability of the mustard compounds to induce gene mutations and chromosome re-arrangements was first detected in experiments with *Drosophila melanogaster*[1-3]. Subsequent investigators showed that this ability extends to all organisms which so far have been tested: *Neurospora*[4], *Tradescantia*[5], *Penicillium*[6], barley[7], bacteria[8] and *Vicia*[9]. There can be little doubt that the mutagenic ability of the mustards is as general as that of X-rays. On the other hand, there is no *a priori* reason for assuming that mustards applied to other organisms will exhibit the same peculiarities of genetical effect which have been found in the work with *Drosophila*, namely, a relative shortage of large re-arrangements[2], deferred action[10,11], and preferential action on immature sperm[12].

It seems worth while to study mustard effects in different species from this point of view. For obvious reasons warm-blooded animals, in particular mammals, are of special interest. It is known that in mammals also mustard gas acts as mitotic poison[13]. This selective action on dividing cells is made use of in the therapeutic treatment of leukæmia and Hodgkin's disease[14]. Proper tests for the production of mutations and chromosome re-arrangements in mammals have, however, not yet been attempted. Apart from their theoretical interest, such tests might acquire practical significance, if in future it should become possible to use nitrogen mustards not only as a palliative in malignant disease, but also to effect more or less permanent cures; for in such cases it would be important to assess the effect of the treatment on the gonads of a patient who afterwards may be able to reproduce.

We have recently started experiments in which male mice of an inbred wild-type strain are treated with a nitrogen mustard (N-methyl di-(2-chloroethyl)-amine), and the progeny are tested for translocations (heritable semi-sterility) and visible mutations. In the first three experiments, twelve mice were each given 0·08 mgm. by intraperitoneal injection. All but one died within a few days. Some of the mice of the third experiment mated before death and produced litters of normal size. Nine of their sons were tested for semi-sterility with negative results. In the second experiment, two out of three treated mice died without progeny. The third survived and mated at least once in the week following treatment. No offspring, however, were produced until about two months later, when full fertility was restored. Of the twenty-four offspring born, sixteen were tested for the presence of recessive gene-mutations by outcrossing each and then backcrossing the offspring to them or mating the offspring *inter se*. In one of these matings a hitherto unknown mutant in its first litter was segregated.

Only a very brief description of the new mutant can be given here. It appears to be due to a single recessive gene, giving normal ratios and having full penetrance. Its visible effects on the mouse are many: the most striking are a peculiar folding of the ears from about one to three weeks of age, absence of hairs on the tail and behind the ears, small kinks at the extreme tip of the tail, and a short and rather thin coat with the hairs tending to point toward the midline of the back. These effects are all very regular in their appearance, except the thinness of the coat, which varies somewhat. Both sexes are fertile, and the females are able to rear their young.

The occurrence of one mutant cannot, of course, be certainly ascribed to the mutagenic action of the treatment, even considering the small number of gametes tested. The discovery of spontaneous visible mutations in mice is, however, a very rare event, even in inbred lines, and the discovery of one among sixteen gametes seems to be extremely improbable. In fact, not all the sixteen gametes were adequately tested. It was calculated, by a method described elsewhere[15], that the equivalent number of fully tested gametes was only 11·3. It seems, therefore, more likely that the mutation was induced than spontaneous, and the experiments are being continued.

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Tissue Distribution of a Radioactive Spinal Anæsthetic

When a spinal anæsthetic leaves the subarachnoid space and the neural elements contained therein, it enters the general circulation, by which agency it is distributed among the various tissues of the body. Hitherto, on account of the technical difficulties attendant upon the estimation of an anæsthetic substance at low concentration in the presence of gross tissue excess, precise studies of tissue distribution have not been made.

To investigate various problems associated with local and spinal anæsthesia, I prepared a radioactive anæsthetic, dibromoprocaine hydrobromide[1]. For the purpose in hand, a reasonably active preparation was requisite, and this was obtained by irradiation in the chain-reacting pile of 30 c.c. of ethylene dibromide containing 5 per cent of aniline[2], followed by a modified Szilard–Chalmers's extraction. The radioactive bromine finally obtained as silver bromide was treated in the manner previously described[1] and the product dibromoprocaine hydrobromide converted into dibromoprocaine hydrochloride, so as to eliminate the ionizable bromine.

The established pharmacology of the nuclear halogens indicates that the bromine atoms are not likely to be split from the benzene nucleus in the course of its metabolism, and I have confirmed this. Consequently the estimation of the radioactivity of specimens derived from the various tissues should provide an index of the concentrations of the original drug in terms of its benzene nuclei, notwithstanding any further additions which may be made to it during its sojourn in the body, and the fate of the side chain.

Cats were employed in the first series of experiments, and these received, by lumbar puncture, doses of dibromoprocaine hydrochloride varying between 0·007 and 0·03 gm. Urine was obtained by catheterization, cerebrospinal fluid by lumbar puncture, bile by aspiration of the gall bladder and blood by cannulation of the carotid artery or ventricular puncture. Autopsies were performed at periods of 1–39 hr. after the administration of the anæsthetic, and specimens taken from the organs to be examined. The tissue samples so obtained were broken down in lithium hydroxide solution under reflux, and the resulting fine suspensions estimated by means of a scaling unit and 'liquid' counter.

In the second series, the anæsthetic was administered intravenously, so as to study the effects on tissue concentration of higher blood levels.

In the intrathecal series, the blood levels fell between 5·4 and 1·3 µgm. per c.c., while, in the case of the intravenous series, maximum blood levels of 44 µgm. per c.c. were investigated.

The tissues examined were skin, kidney, liver, duodenum, spleen, muscle, lung, testis, thyroid, spinal cord, spinal roots, medulla oblongata and sciatic nerve. Estimations of urine, bile and duodenal contents, cerebrospinal fluid and fæces were also made.

Apart from spinal cord and spinal roots, only kidney and liver showed a concentration of the drug above that obtaining in the blood, the former reaching a maximum of 9 times and the latter 3 times the blood concentration; while their secretions, urine and bile, showed maximal concentrations of 133 times and 27 times that of the blood respectively; the concentration of the drug in the duodenal contents followed that of the bile. Investigation of the fæces showed that part at least of the dibromoprocaine molecule was excreted *via* the gut.

The concentrations of anæsthetic in spinal cord, roots and cerebrospinal fluid were not directly dependent on blood concentration, since the drug was administered by lumbar puncture. It is of interest, however, that the spinal roots showed a higher concentration of anæsthetic per unit mass than did the cerebrospinal fluid in which they were bathed.

As regards the drug content of the remaining tissues, the lung showed the highest and muscle tissue (gastrocnemius) the lowest, attaining 0·8 and 0·1 times blood concentration respectively: the other tissues fell between these two limits.

With increased time between administration and autopsy, a slight increase in the blood-tissue ratios was observed, due, probably, to leakage from the vascular bed of the organs to the tissues themselves; this effect was maximal about twenty hours after administration of the spinal anæsthetic, with subsequent steady decline. In the case of the liver and kidney, tissue concentration was greatest about 1½ hr. after injecting the drug, at which time blood and bile concentrations were also maximal.

When the drug was given intravenously, the cerebrospinal fluid in the lumbar theca showed a barely estimable amount of tracer, while the cord showed 0·05–0·1 times and the roots 0·3–0·4 times blood concentration.

At high blood levels, the concentrating activity of liver and kidney appeared to decrease, due presumably to a 'swamping' of these organs; but variations in blood levels had little effect on the blood-tissue ratios elsewhere. Tracer could be detected in the circulation at considerable intervals (70 hr.) after its administration, and, at this period, both liver and kidney concentrations were also observed to drop, in spite of a persistent blood level at which active concentration had previously occurred.

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Epidermal Mitosis in Relation to Sugar and Phosphate

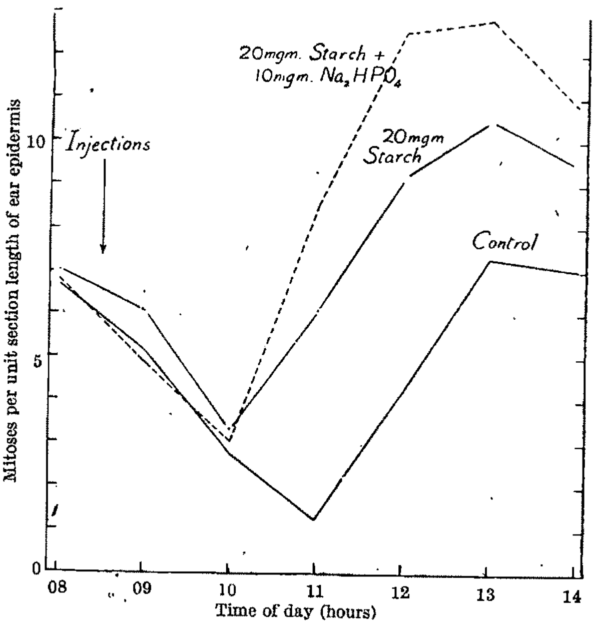
DESCRIPTIONS have been given of the diurnal mitosis cycles in the ear epidermis of the adult male mouse, and the conclusion has been reached that the form of these cycles is determined by the daily routine of activity and of rest[1]. During bodily activity, the mitosis-rate is low, and during sleep and rest it is high. In extending these observations, two further important facts were noticed, namely, that excessive muscular exercise is followed by an abnormal depression of the mitosis-rate[2], and more recently, that the same effect can be induced by extreme cold. Since in both these situations there is a drain on the sugar reserves of the body, in the one case for muscle contraction and in the other for heat production, it was suspected that an abundance of sugar may be a critical factor in the development of a high mitosis-rate.

Variations in the mitotic activity of the ear epidermis following injections of starch alone and of injections of starch together with disodium hydrogen phosphate at 08·30 hr.

Time of day	No. of observations per group	Av. numbers of mitoses per cm. length of sections cut 7 μ thick		
		of 10 control mice injected with saline alone	of 10 mice injected with 20 mgm. of starch in saline	of 10 mice injected with 20 mgm. of starch and 10 mgm. of $Na_2HPO_4.2H_2O$ in saline
08·00	100	6·6 ± 0·19	7·0 ± 0·11	6·7 ± 0·12
09·00	100	5·1 ± 0·18	6·1 ± 0·11	4·9 ± 0·10
10·00	100	2·7 ± 0·06	3·3 ± 0·08	3·1 ± 0·09
11·00	100	1·3 ± 0·05	6·1 ± 0·19	8·5 ± 0·14
12·00	100	4·0 ± 0·10	9·4 ± 0·14	12·6 ± 0·21
13·00	100	7·3 ± 0·15	10·5 ± 0·12	12·8 ± 0·25
14·00	100	7·0 ± 0·14	9·5 ± 0·16	10·8 ± 0·18

After preliminary experiments, the following method of administering extra sugar to a mouse was adopted. A subcutaneous injection of a solution of 20 mgm. of starch in normal saline was given to each animal at 08.30 hr. This resulted in a steep rise in the concentration of the blood sugar, which reached a maximum at about 10.00 hr. and returned to normal soon after midday. The accompanying changes in the epidermal mitotic activity were followed by the removal of pieces of ear at hourly intervals from 08.00 to 14.00 hr., and typical results from one of these experiments are shown in the accompanying table. It should be noted that only male mice were used in order to avoid the effects of the œstrous cycle. The results show clearly that a marked stimulation of mitotic activity followed the injection of the starch. There was a time lag of about 1½ hr. before the effect began to develop, but after that the rise in mitotic activity was rapid. The later and smaller rise in the mitotic activity of the control mice was due to the effect of the afternoon sleep period.

The most plausible theory of the function of sugar in stimulating mitotic activity seems to be that it acts as a source of energy. This being so, it might be expected that interference with the process of phosphorylation by means of phloridzin injections would depress mitotic activity, and this has, in fact, been



The variations in the mitotic activity of the ear epidermis of adult male mice following injections of starch and of starch together with disodium hydrogen phosphate confirmed. Conversely, it might also be expected that by injecting phosphate together with starch an even greater mitosis stimulation would be achieved. That this also is the case is shown in the table and in the graph.

This demonstration of the importance of sugar to the process of cell division sheds light on several well-known phenomena, of which the following may be selected for comment. It is common knowledge that the vaginal epithelium becomes charged with glycogen, and produces what appears to be lactic acid, at about the time when it develops high mitotic activity in response to œstrogenic stimulation[3]. Similarly, it has been shown[4] that the administration of œstrogens causes a considerable increase in the blood-sugar level, in apparent preparation for the wave of mitotic activity which follows such treatment. Finally, it is also appropriate to notice here that the induction of a hyperglycæmic condition in canaries favours the rapid multiplication of the malarial parasite *Plasmodium cathemerium*, with a consequent increased death-rate among the hosts[5]. Conversely, in canaries made hypoglycæmic with insulin, fewer parasites develop and larger numbers of the birds survive the infection. During the present work it has also been demonstrated that a reduction in the blood-sugar level following injections of insulin is accompanied by a severe depression of epidermal mitotic activity. All these observations are being published in full elsewhere.

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Relation of Molybdenum and Manganese to the Free Amino-Acid Content of the Cauliflower

MOLYBDENUM[1,2] and manganese[3,4] are both believed to be concerned in the chain of reactions beginning with the reduction of nitrates and ending in protein assimilation in higher plants, although they may also have other functions. It has been shown that lack of either element may result in a marked accumulation of nitrates in the leaves of plants. 'Soluble nitrogen' and protein nitrogen fractions also may be less when molybdenum is withheld, but may be nearly normal in the absence of molybdenum when ammonium sulphate is used instead of nitrate as a source of nitrogen[2]. A relationship between manganese and molybdenum has been reported for flax grown in water culture[5,6], where the harmful effects of excess of manganese (and of certain other metals) were reduced by additional amounts of molybdenum.

As there is no evidence that either of these elements can replace the other, it may be assumed that they act independently in the chain of reactions occurring between nitrate reduction and protein formation.

The present note gives preliminary results of experiments designed to study the interrelationships of molybdenum and manganese and to obtain evidence of the reactions catalysed by these elements and their sequence.

Cauliflower plants, variety Majestic, were grown in sand culture using the technique already described[1], with three levels each of molybdenum (nil, 0·015 and 9·5 p.p.m.) and of manganese (0·0055, 0·55 and 55 p.p.m.), ranging for each element from deficiency through normal to toxicity. These plants provided material for the study of nitrate accumulation, as determined on fresh tissue extracts[7], and of the free amino-acid present in the 70 per cent alcoholic extracts of partly expanded leaves. The presence of amino-acids was followed by paper chromatography[8], as recently applied to plant tissues by Dent *et al.*[9] and by Allsopp[10]. Preliminary one-dimensional chromatograms (phenol as solvent) showed variations in amino-acid content quite clearly. Two-dimensional chromatograms (phenol and collidine as successive solvents) permitted identification of several amino-acids[9] by comparison with control runs using known mixtures. The relative concentrations of the amino-acids thus detected were assessed visually in terms of the intensity and area of the colour produced with ninhydrin.

Nitrate accumulated to abnormally high concentrations when either element was deficient, and in this respect the low concentration of manganese appeared to be more conducive to nitrate accumulation than that of molybdenum—an element known to be required in far smaller amounts. Molybdenum deficiency resulted in a marked reduction in the concentrations of most amino-acids, while a few were scarcely affected. The effects of molybdenum and manganese on the free amino-acid content of the leaves were found to be interdependent. Generally a decrease in the molybdenum-level was paralleled by a reduction in the amino-acid concentration, while a similar change of manganese-level acted in the opposite direction, that is, a deficiency of manganese was associated with an increase in amino-acid concentration. The effect of change in molybdenum-level was most marked under conditions of manganese deficiency, while change in manganese-level showed the greatest effect in the presence of a high level of molybdenum.

These changes were particularly great for arginine and were also pronounced with alanine, aspartic and glutamic acids, proline, and an unidentified acid or possibly peptide. The acid amides, asparagine and glutamine, showed similar changes. Another unidentified amino-acid or peptide, however, showed an opposite effect with respect to manganese and appeared more strongly in the presence of an excess of this element. The amounts of some amino-acids were only affected by molybdenum variations from deficiency to normal levels, but for others the effective range lay between the normal and excess levels. Arginine, proline and one of the unidentified substances, however, showed variations over the whole range of molybdenum concentrations. These interdependent effects and the fact that nitrate accumulates in the absence of either molybdenum or manganese may ultimately be explained in terms of the kinetics and mass-action laws of the respective reactions controlled by each element.

The evidence so far available is, however, consistent with the hypothesis that molybdenum and manganese catalyse separate reactions, both of which affect the concentration of amino-acids as intermediate metabolites in nitrogen metabolism. The evidence also suggests that whereas molybdenum controls one or more reactions leading from nitrate to amino-acid production, manganese may function later in the chain when amino-acids already produced are further metabolized.

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Tellina magna found in Orkney

DURING Easter 1947, an inspection was made of the seaweed cast up on the west mainland of Orkney. One heavy cast, 3 ft. thick at the water's edge, was found in a sandy bay north of the graveyard north-west of Stromness and opposite the northern extremity of Hoy. The coast is rocky with sandy bays. The rocks are Old Red Sandstone, which erode to form flat slabs sloping towards the sea. About half a mile offshore, a reef of similar rock formation is exposed at low water. There is little chance of anything remaining intact before being cast ashore as the Atlantic waters break on this coast.

The cast weed on this occasion, composed mainly of the fronds of *Laminaria Cloustoni*, had acted as a buffer for several large shells, such as *Pecten*, which were found intact. Normally, such shells become so broken up that they merely add to the shell sand comprising the foreshore in this area.

From among the cast weed a bivalve, 4 in. long, was picked up which when discovered had its two halves hinged; the contents were absent. It has now been identified as *Tellina magna*, a native of the East American coast, North Carolina to West Indies—and is, I am informed, the first recorded instance of a marine invertebrate from the American continent to be found in British waters. Subsequent visits to the same area have produced only limpet shells and one small bivalve. There can be no doubt the cast weed was responsible for bringing the shell ashore intact. How the animal (or its ancestors) crossed the Atlantic can only be speculation. Whether living specimens are to be found off this Orkney coast a dredging expedition must decide.

I wish to acknowledge the interest of the late Mr. R. Elmhirst, of the Marine Biological Station, Millport, Prof. C. M. Yonge, of the University of Glasgow, and Dr. A. C. Stephens, of the Royal Scottish Museum, who were responsible for the identification.

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Nuclear Capture of μ-Mesons

IT is well known from delayed-coincidence experiments[1] that negative μ-mesons (mass 215) stopping in light atoms undergo electron decay, whereas those stopping in substances of high atomic number undergo nuclear capture. Both photographic plate[2,3] and cloud-chamber evidence[4,5] shows that very few or none of the μ^--mesons produce nuclear disintegration stars in heavy elements. Counter-work[6] precludes production of photons, though there is evidence for emission of neutrons following meson capture[7,8]. It is of interest to discuss the above evidence in the light of observations on μ-mesons stopping in nuclear emulsions.

The emulsion consists of microcrystals of silver bromide, about $0{\cdot}2\,\mu$ in diameter, suspended in gelatin. Thus, a meson coming to rest in the emulsion will, in general, spend the last fraction of a micron of its range either entirely within heavy atoms, or in light ones. Hence the probability of the meson stopping in heavy or light atoms will be almost independent of the complicated processes of energy-loss below a velocity of about 5×10^8 cm./sec., and can be estimated from experimental data on stopping power. Allowing a positive excess of 15 per cent, we thus calculate that the proportion of mesons which are negative μ-mesons stopping in silver or bromine atoms is 35 per cent. In Kodak electron-sensitive plates exposed to cosmic rays, we in fact observe that 30 ± 6 per cent of the single mesons (the great majority of which are known to be μg particles[3]) fail to give a decay electron on cominto rest. This figure is in good agreement with that obtained by other observers[9].

First of all, it is clear that, quite apart from the fact that it is contrary to the concept of short-range nuclear forces, the rest-energy of the μ-meson cannor be shared directly among several nucleons, othetwise we should inevitably observe fast protons emitted. Let us suppose that the entire rest-energy of the μ-meson is converted into kinetic energy of (*a*) two, and (*b*) one fast neutron. Process (*a*), which is the same as that which probably occurs following negative π-meson capture[2], should result in many cases in the formation of a star, for it is difficuil to see how at least one of the neutrons can avodt producing general nuclear excitation and evaporation. If, as seems extremely unlikely, the latter did not occur, half the resulting palladium or selenium isotopes would be stable, and the remainder would probably be β-active[10]. If these were short-lived isotopes, the proportion of mesons not giving electrons would be greatly reduced. The β-particles would also be immediately distinguishable on account of their small momenta. In actual fact, the momenta of the decay electrons, obtained from Coulomb scattering measurements, appear in all cases to exceed 10 MeV./c. (Where accurate measurements on long tracks are possible, the observed values are much higher than this[9].) Thus any β-decay which might occur would have to be fairly long-lived. In this connexion, it is interesting to note that we have observed no significant difference between the proportion of mesons not giving electrons in plates exposed for six days at Jungfraujoch and developed four days later, and those in plates exposed for three weeks and developed one month later.

In process (*b*) the nucleus (which will be stable to β-decay) must take up the momentum of the neutron, amounting to 450 MeV./c., and will have a range in the emulsion of 1·7 μ [11]. However, from fifteen mesons in Kodak plates not giving decay electrons, we observe only two tracks which could possibly be attributed to recoils. An accurate estimate of the number of such recoils is difficult to obtain because their tracks can easily be confused with Coulomb scattering at the very end of the meson track. We obtain an *upper* limit if we double the number of apparent recoils travelling backwards with respect to the general direction of the meson.

Observations were therefore made on single mesons stopping in fine-grain plates (Ilford *C*2, not capable of recording decay electrons). From 190 meson tracks examined (about sixty of which would be negative μ-mesons stopping in heavy atoms), only eight recoil tracks of ranges of the above order of magnitude were obtained. If all gave recoils, thirty would be backwards and we should expect many more than eight of these to be definitely observable. About one-seventh of the mesons stopping in our plates are π^--mesons producing stars. A further quarter of all the π^--mesons are known to be captured in heavy nuclei and give rise to emission of neutrons only[2] (apart from a recoil); these will be classified as single mesons. They constitute about 5 per cent of all the single mesons and can thus account for at least half the observed recoils; the remainder can be quite reasonably attributed to large-angle Coulomb scattering along the meson tracks. This analysis demonstrates the absence of a homogeneous group of recoil tracks of range $\sim 1{\cdot}7\,\mu$, indicating that the resultant momentum of a nucleus capturing a μ^--meson must be $\leqslant$ 450 MeV./c. The minimum length of recoil observable is estimated at 0·5 μ, corresponding to a recoil momentum of 150 MeV./c.

We must therefore assume that part of the rest energy of the meson is converted into kinetic and rest energy of a light neutral particle. If the remainder appears as kinetic energy of a single neutron, the maximum energy the latter could have, to make the nuclear recoil just unobservable, would be 25 MeV. It is extremely unlikely that a neutron of such low energy would give rise to charged-particle emission in traversing the nucleus, but one or two further neutrons might be evaporated off[12].

Thus, so far as the experimental data permit, we can conclude that the capture of a μ^--meson by a heavy nucleus leads to the process

$$\mu^- + P \rightarrow N + \nu,$$

where ν denotes a light neutral particle (neutrino ?). This is precisely the interaction predicted theoretically[13] as a consequence of the μ-decay of the π-meson, assumed to be of the form $\pi \rightarrow \mu + \nu$.

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Electron–Atom Ratios in Alloy Phases as a Monotonic Sequence

1/1, 3/2, 5/3, 7/4, 9/5, 11/6, 13/7 . . . $(2n-1)/n$ . . . 2/1 is a monotonic sequence[1] tending to the limiting value 2/1 when *n* is increased indefinitely. This sequence is a systematic representation of the ratio of the number of free valency electrons to atoms in the well-known Hume-Rothery[2] series of electronic compounds.

For example, in the copper–zinc system, where copper is regarded as monovalent and zinc is divalent, we should have a series of improper fractions, each conforming to the above sequence, and each corresponding to a different phase (see Table 1).

Table 1

Designation	α	β	γ	ε	η
Electron/atom ratio—*Ve*/*A*	1/1	3/2	5/3	7/4	2/1
Empirical formula	Cu	CuZn	$CuZn_2$	$CuZn_3$	Zn
Atomic % Zn	0	50	66·7	75	100
True limits of phase field (400° C.)	0 37	45 49	57 67	77 87	97 100
Crystal structure	f.c.c.	b.c.c.	'γ' type	h.c.p. $c/a = 1{\cdot}55$	h.c.p. $c/a = 1{\cdot}86$
Structural formula	Cu	CuZn	Cu_5Zn_8 Cu_4Zn_9		Zn

In each case the simple formulæ given in the third row fit in well enough with the respective limits of composition, although they are, of course, empirical in origin and are not necessarily related to the crystal structures. The composition limits are decided in other ways, for example, by the free-energy relations between neighbouring phases or by the Brillouin zone theory[3], which does not, however, give rise to any integral values, serving as a rule merely to fix an upper limit to the electronic concentration. For example, the α-phase (face-centred cubic) becomes unstable about the composition limit corresponding to $Ve/A = 1{\cdot}36$ (36 atomic per cent zinc), while the β-phase (body-centred cubic) agrees with $Ve/A = 1{\cdot}48$ (48 atomic per cent zinc).

The range of the ε-phase (hexagonal close-packed) varies greatly from system to system. However, the ratio 7/4 is usually regarded as typical and receives support on theoretical grounds.

An even more striking illustration of a monotonic sequence is afforded by the copper–aluminium system, as can readily be shown. It now appears that in addition to the typical γ-phase (analogous to γ-brass) there are three other closely related phases, two (γ_1 and γ_2) being obtained at room temperature[4], while ε is got by quenching[5]. Further, there is a phase beyond this region (ξ) which has many structural similarities to the γ-phase. Ultimately this complicated region in the equilibrium diagram concludes with the η-phase (CuAl). There are, in all, eight different structures with from one to two free valency electrons per atom. Within each of these phase fields, the ratio of the numbers of free valency electrons to atoms may be represented by the equation $Ve/A = (2n - 1)/n$. Table 2 shows how well the monotonic relationship is observed.

The empirical formulæ $CuZn_2$ and Cu_2Al here allotted to the γ-phase are included well within the respective composition limits of these phases, although they do not correspond with the theoretical atomic distribution, which must conform with a unit cell of 52 atoms.

Table 2

Designation	α	β	γ	γ_1	γ_2	ε	ζ'	η
Electron/atom ratio = Ve/A	1/1	3/2	5/3	7/4	9/5	11/6	13/7	2/1
Empirical formula	Cu	Cu_3Al	Cu_2Al	Cu_5Al_3	Cu_3Al_2	Cu_7Al_5	Cu_4Al_3	CuAl
Atomic % Al	0	25	33·3	37·5	40	41·7	42·9	50
True limits of phase field	0 20	25 approx.	31·5 35·2	35·4 38·0	38·3 40·2	Inc.		less than 50
Crystal structure	f.c.c.	b.c.c.	type	Deformed 'γ'		Related to γ		
Structural formula	Cu	Cu_3Al	Cu_9Al_4 $Cu_{17}Al_9$	$Cu_{32}Al_{19}$	$Cu_{30}Al_{20}$			
Space group			$P\bar{4}3m$	Cm	$R3m$			

For this reason, Cu_5Zn_8 and Cu_9Al_4 are preferred to the empirical formulæ, giving in both instances the somewhat lower ratio $Ve/A = 21/13$ (1·615 instead of 1·667).

However, the exact composition for Cu_9Al_4 is a two-phase alloy ($\alpha + \gamma$), showing that the crystal structure is not a decisive factor in fixing the phase boundaries. According to Konobeevsky[6], the exact upper limit for the γ-phase at $Cu_{17}Al_9$ corresponds to the complete filling of the first Brillouin zone, which is limited by the crystallographic planes (330) and (411). It is interesting to note that the approximate upper limit for γ-brass also agrees with a ratio $Ve/A = 22/13$, the appropriate formula being Cu_4Zn_9. Thus we have in addition to the empirical formulæ ($CuZn_2$ and Cu_2Al) both upper and lower limiting values for the phases. The corresponding formulæ (Cu_5Zn_8—Cu_4Zn_9 and Cu_9Al_4—$Cu_{17}Al_9$) indicate that the ratio Ve/A lies between 21/13 and 22/13.

Conclusion. There is a tendency for many alloy phases to occur when the ratio of the number of free valency electrons agrees with the monotonic sequence $(2n - 1)/n$, where $n = 1, 2, 3, 4, 5, 6, 7$. The characteristic ratio for the γ-phases would then be 5/3 instead of 21/13, although the crystal structures of Cu_5Zn_8 and Cu_9Al_4 require the latter value, while the upper limiting compositions Cu_4Zn_9 and $Cu_{17}Al_9$ point to the higher value 22/13. A publication will appear shortly to show why the ratios 21/13 and 22/13 are so very important.

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Flow of Adsorbed Molecules

JUST as Knudsen and others[1] have shown for single capillaries, flow of a gas through a porous medium also undergoes a transition from viscous flow to molecular flow when pore diameters become comparable in size with the mean free path of the gaseous molecules. The position has been reviewed recently[2], but more data in the molecular flow region are desirable. I have therefore been studying the flow of various gases through plugs of 'Linde silica', a finely divided, amorphous silica stated by the makers to have a maximum particle size of 0·05 μ. The experiments cited here were carried out on a single plug compressed to a porosity (ε) of 0·678. The specific surface, S_0, calculated from the permeability equation of Carman and Arnell[2], was $2·35 \times 10^6$ cm.²/cm.³. This gives an equivalent pore diameter $\frac{4\varepsilon}{(1-\varepsilon)S_0} = 3·6 \times 10^{-6}$ cm., which was usually well below the mean free path of the various gases studied. Application of the Brunauer–Emmett–Teller calculation[3] to gas adsorption isotherms gave $S_0 = 2·8 \times 10^6$ to $4·1 \times 10^6$ cm.²/cm.³, indicating that particles possibly possess an internal surface which is not accessible to flow. To cover a wide range of molecular weights, flow-rates were measured at 22° C. for hydrogen, air, carbon dioxide and 'Freon-12', CF_2Cl_2, all of which gave consistent values for S_0.

The flow-rate for sulphur dioxide, however, was distinctly higher than expected. The boiling point of sulphur dioxide is such that it is appreciably adsorbed at 22° C., and it was suspected that this might be responsible. Further experiments were therefore carried out at 0° C., and the results, summarized in the accompanying table, seem to show clearly that the difference between observed permeabilities and those calculated on the assumption that $S_0 = 2·35 \times 10^6$ cm.²/cm.³ does depend on adsorption. Permeabilities are given by $pQL/A\Delta p$, where Q is rate of flow in cm.³/sec., measured at the mean pressure $p = (p_1 + p_2)/2$, at the temperature of the plug, L cm. and A cm.² are length and cross-section of the plug, and Δp is pressure difference across it. The pressure, p_1, on one side of the plug, was always atmospheric (about 660 mm. at Pretoria), while p_2 was varied and could be either greater or smaller than p_1. Adsorption was also measured, and has been expressed as v cm.³ of liquid sulphur dioxide adsorbed per cm.³ of plug, assuming density of adsorbed sulphur dioxide is equal to that of the liquid in bulk, that is, it gives the pore-space occupied by liquid sulphur dioxide. The value in brackets for $p_2 = 1{,}160$ cm. at 0° C. is assumed, on the basis that the pore-space is filled by condensed sulphur dioxide. At $p_1 = 660$ mm., corresponding values for adsorption are 0·039 at 22° C. and 0·072 at 0° C. From these, the values $\Delta v/\Delta p$ have been calculated in the last column of the table.

Temperatures (° C.)	p_2 (mm.)	Calculated permeability × 10³	Observed permeability × 10³	Pore space occupied by adsorbed SO_2 at p_2	$\frac{\Delta v}{\Delta p} \times 10^5$
22	83	1·17	1·40	0·012	4·7
22	1331	1·25	1·47	0·064	3·9
0	44	1·13	1·52	0·013	9·6
0	90	1·14	1·54	0·020	8·8
0	896	1·19	1·77	0·108	15·2
0	935	1·19	1·88	0·118	17·0
0	1067	1·20	2·16	0·234	40·2
0	1160	1·21	4·28	(0·68)	(121)
0	1300	1·22	1·57	—	—

The most remarkable feature is the extremely rapid increase in permeability at 0° C. as the saturation vapour pressure of liquid sulphur dioxide, 1,161 mm., is approached; especially since one would expect the volume occupied by adsorbed sulphur dioxide to restrict flow in the gas phase. Presumably, the reason is that the concentration gradient in the adsorbed film increases much more quickly than the pressure drop across the plug in this region, as shown by $\Delta v/\Delta p$.

The mobility observed for the adsorbed layer could not be predicted from the properties of liquid sulphur dioxide. If pores were wholly filled with the liquid, and the permeability is calculated from its viscosity, it is found to be of the order of 5×10^{-4} times the calculated gaseous permeability, that is, liquid sulphur dioxide should block the pore-space. Evidence favouring this is that, when $p_2 = 1,300$ mm., the initial permeability is still faster than for $p_2 = 1,160$ mm., but decreases steadily over many hours to the relatively low value cited. Presumably, the high-pressure side of the plug becomes choked with condensed sulphur dioxide, which evaporates as it flows to the low-pressure side.

These observations bear out those of Tomlinson and Flood[4], who studied the flow of diethyl ether and ethyl chloride vapours through rods of activated charcoal. These workers did not observe the rapid increase of permeability near the saturation pressure of the vapours, but did note that the difference between observed and calculated permeabilities increased at low values of the mean pressure. This is not unreasonable, since the gradient of an isotherm adsorption, that is, $\Delta v/\Delta p$, becomes considerably steeper at low relative pressures.

Further experiment has shown that other gases show qualitatively similar behaviour. For example, at 22° C., CF_2Cl_2 (b.p. − 33° C. at Pretoria) gives a permeability in agreement with calculation; at 0° C., it behaves like sulphur dioxide at 22° C.; at − 25° C., it shows the same large increase of permeability as p_2 approaches the saturation vapour pressure, and a slow approach to a relatively small permeability when p_2 exceeds this. It is hoped to publish a fuller account of these data elsewhere.

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Daily Magnetic Variations near the Equators

THE establishment of the observatory at Huancayo, Peru, near the magnetic equator, led to the discovery of daily magnetic variations, both solar and lunar, approximately twice as great as those previously found in other tropical regions. McNish[1] has sought to explain this anomaly by qualitatively modifying the Balfour Stewart – Schuster 'dynamo' theory to allow for the non-coincidence of the earth's magnetic and geographic axes. According to McNish, enhanced magnetic variations should occur in the areas between the magnetic and geographic equators. On the other hand, Egedal[2] and Chapman[3] have recently put forward data from tropical regions which appear to show that the distribution of the phenomenon is more complex than could be explained by McNish's suggestion.

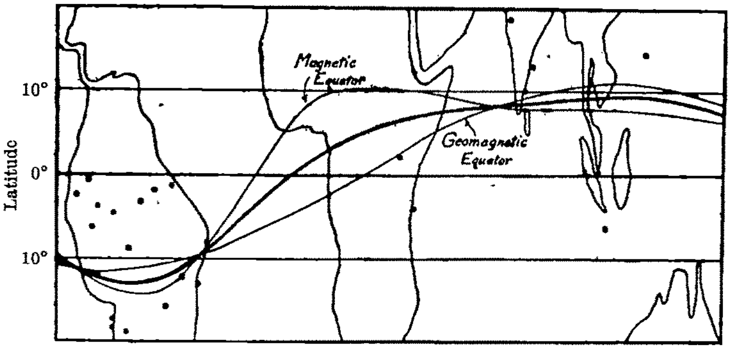

Fig. 1. Distribution of equatorial locations studied by Egedal and Chapman for anomalous magnetic variations. The heavy line is midway between the magnetic and geomagnetic equators

Now in 1908 Schuster[4] himself gave a quantitative account of the modifications introduced into the 'dynamo' theory by the non-coincidence of the earth's magnetic and geographic axes. It is easy to show that this produces symmetry of the variations about an equator which lies between the magnetic and true equators: the variations should show a shallow maximum at this 'magneto-dynamic' equator. McNish's qualitative arguments agree with Schuster's and lead to a small increase of the magnetic variations in the regions he specified: they cannot account for the very large increases found.

It is of interest to investigate whether the data examined by Egedal and Chapman show a symmetrical distribution of the anomaly about an equator. (The distribution of the sites examined by these authors

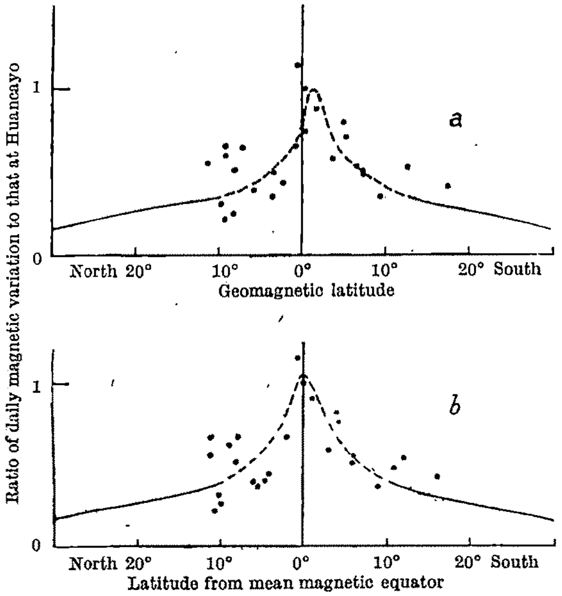

Fig. 2. Amplitude of daily magnetic variations plotted against (*a*) geomagnetic latitude, (*b*) latitude measured from a mean magnetic equator

is shown in Fig. 1.) The large variation revealed by Chapman for Uganda, which is not close to the *magnetic* equator (that of zero inclination), indicates that the latter is not the line of maximum anomaly.

The magnitude of the variations is plotted against *geomagnetic* latitude in Fig. 2*a*. (This latitude is measured from the equator of the earth's dipole axis.) It will be seen that the distribution is not symmetrical about this equator. In Fig. 2*b* the magnitude is plotted against latitude measured from an equator which is midway between the magnetic and geomagnetic equators. In this case approximate symmetry is obtained.

It would seem, therefore, that the observed anomalies require the existence in the ionosphere of a narrow region of high electric *conductivity* (about 15° of latitude wide) encircling the world approximately mid-way between the magnetic and geomagnetic equators.

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Oct. 27.

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Emission Spectrum Attributed to Cadmium Fluoride

EMISSION bands attributed to cadmium fluoride by Asundi, Samuel and Zaki-Uddin[1] have been shown by Pearse and Gaydon[2] to be due to calcium fluoride. In their work, Pearse and Gaydon found six diffuse, band-like structures, three degraded to the red and three to the violet, in the spectrum of a cadmium arc fed with cadmium fluoride. These structures were tentatively ascribed to cadmium fluoride. Howell[3] gave reasons for believing that they are indeed due to cadmium fluoride, and arranged them into two band systems. However, the absorption spectrum of cadmium fluoride was investigated by Fowler[4] and nothing found corresponding to these emission bands; though, of course, it is quite possible for bands observed in emission to be missing in absorption and *vice versa*. Nevertheless, a new investigation of the emission spectrum was felt to be desirable.

Experiments were made with flames and arcs containing cadmium fluoride; but it was not found possible to excite in emission any of the bands that had been attributed to cadmium fluoride in absorption. It was found, however, that the six diffuse structures could be excited in the arc between cadmium metal electrodes without the presence of fluoride, and that the structures disappeared as the arc chamber was evacuated. This led to their identification with lines listed in Fowler's "Report"[5] (see table).

The lines are all of the combination type, strictly forbidden by elementary selection rules. Three of the lines, λλ 2961·48, 2862·30, 2818·73, which form the multiplet $5s5p\ {}^3P^0{}_{0,1,2} - 5s4f\ {}^3F^0{}_{2,3,4}$ have been studied in detail by Ornstein and Burger[6], who conclude that the radiation is of the electrical dipole type forced by ionic electric fields. This conclusion is supported by the observations of Fukuda, Kayama and Uchida[7] on the excitation of all six of the lines in a high-current arc and also by Fujioka's study of their Stark effect[8]. The great asymmetry of the lines is brought about by the perturbation of the atomic energy-levels by the ionic fields forcing the radiation.

'CdF bands'			Cd lines		
λ(A)	I		λ(A)	I	
3005	(5)	R	3005·41	(1)	r
2961·5	(5)	V	2961·48	(4)	v
2908	(2)	R	2908·74	(1)	r
2904	(1)	R	2903·13	(1)	n
2862	(5)	V	2862·30	(2)	v
2819	(3)	V	2818·73	(1)	v

R = band degraded to red
V = band degraded to violet
r = line shaded to red
v = line shaded to violet
n = diffuse line

It is now well known that in certain circumstances bands may be mistaken for lines. This example shows that it is also necessary to beware of lines that may be mistaken for bands.

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Magnetic Polarizability of the Electron

THE anomaly of the magnetic moment of the electron has been explained by Schwinger[1] as due to the interaction of the electron with the zero-point fluctuations of the radiation field. A particularly simple derivation has recently been given by Luttinger[2]. Luttinger considers the state of an electron in a constant magnetic field H such that its energy is exactly equal to mc^2, the energy of the orbital magnetic moment cancelling the energy of the spin magnetic moment. He then calculates the self-energy of the electron in this state due to the interaction with radiation, and expands this in powers of H. The term independent of H is divergent, being the well-known self-energy of the electron in the absence of any field, while the term proportional to H is finite and given by ($\hbar = c = 1$):

$$E = -\frac{e^3H}{4\pi m}. \quad (1)$$

This gives the radiative correction to the magnetic moment of the electron in agreement with experiments. It will be of interest to investigate also the terms of higher powers in H, for example, that proportional to H^2, which represents a magnetic polarizability of the electron. It is important to ascertain whether all the intrinsic properties of the electron are finite, except the self-energy and self-charge, which are infinite. Since the electron has spin $\frac{1}{2}$, field-independent moments other than a magnetic moment cannot exist; but polarizabilities and higher induced moments exist. To calculate the magnetic polarizability it is necessary only to carry the expansion in H one step further. This we have done, and it is found that this term is convergent for large values of the momentum of the virtual photons but diverges logarithmically for low values. This divergence, however, is due to an unpermissible expansion in powers of H, as can be seen by summing up the divergent contribution of this term with other contributions occurring in the higher powers of H. The result is a term involving $H^2 \log H$. Thus we find for the contributions to the self-energy due to the static and dynamic interactions with the virtual photons:

$$\left.\begin{aligned} E_{\text{static}} &= -\frac{e^4H^2}{90\pi m^3} + O(H^3) \\ E_{\text{dynamic}} &= -\frac{e^4H^2}{4\pi m^3} - \frac{2e^4H^2}{3\pi m^3}\log\frac{2eH}{m^2} + O(H^3) \end{aligned}\right\} \quad (2)$$

This result is finite, and it is quite easy to see that the terms proportional to higher powers of H are also finite. Owing to the logarithmic dependence on H, strictly speaking it is not correct to call (2) the 'magnetic polarizability', but this is of little importance. (2) is still smaller than (1) by a factor of the order $\frac{\mu_0 H}{mc^2} \log \frac{mc^2}{\mu_0 H}$ (where μ_0 is the Bohr magneton), which makes the polarizability for all practical purposes far too small to be observed at present.

I wish to express my thanks to Prof. Heitler for suggesting this investigation, and for valuable discussions.

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Analogue Calculating Machine for Functions of a Complex Variable

WE have recently been concerned with a physical analogue to assist in dealing with functions of the complex variable, z, of the class:

$$f(z) = \frac{a_n z^n + a_{n-1} z^{n-1} + a_{n-2} z^{n-2} \ldots a_0}{b_m z^m + b_{m-1} z^{m-1} + b_{m-2} z^{m-2} \ldots b_0}$$

$$m \sim n = 1;\ a_n\ b_m \text{ real.} \quad (1)$$

This analogue device has many applications to electric network analysis and synthesis, and to other vibration problems; however, its capabilities would appear to be of sufficiently broad mathematical interest to warrant more general attention.

Such functions satisfy Laplace's equation $\nabla^2 f(z) = 0$, except at the singularities, and so may represent two-dimensional physical potential fields, for example, (*a*) an electrostatic field, (*b*) a stretched membrane, (*c*) a current-carrying conducting sheet, etc., with the singularities represented respectively by point charges, point displacements and point current sources. The system (*c*) has been found particularly suitable, using a shallow layer of electrolyte and by taking certain precautions to eliminate the boundary error[1], so that the electrolyte surface represents the infinite z-plane and includes an accessible 'infinity' point. A fine point electrode, carrying a constant current, placed at the point z_r, sets up a potential at any other point z proportional to $\log |(z-z_r)|$ and a potential gradient represented in both magnitude and direction by the conjugate of $(z - z_r)^{-1}$, both of which may be measured electrically. These properties form the basis of the analogue, which is applied in two different ways.

In the first application, the real, imaginary or complex zeros of either the numerator or denominator of (1) may be found, by exploring the potential gradient over the electrolyte surface set up by suitably placed electrodes, in order to locate the points of zero gradient. Furthermore, the case of complex coefficients, $a_n, \ldots b_n, \ldots$ etc., may also be dealt with[2].

Secondly, if $f(z)$ be factorized by this method, it may be represented in logarithmic form:

$$\log f(z) = \sum_{z=1}^{n} \log (z - z_z) - \sum_{p=1}^{m} \log (z - z_p), \quad (2)$$

by electrodes placed at the zeros z_z and poles z_p carrying currents proportional to their multiplicity (if multiple singularities are present). The potential over the electrolyte surface determines the modulus of $\log f(z)$, and, further, it may be shown that its argument is represented by the summation, along a line parallel to the imaginary axis, of the potential gradients (parallel to the real axis) between z and the real axis. This modulus and argument measurement, especially along the imaginary axis, has been reported previously.

Thirdly, with $\log f(z)$ thus represented, the residues at the simple poles of $f(z)$, which are in general complex, may be measured. The residue ν_p at a pole z_p is the value of $f(z) \, . \, (z-z_p)$ at $z = z_p$; this may be measured physically by removing the electrode at z_p and measuring $\log f(z)_{z=z_p}$ as explained above. A somewhat more complicated process enables the residues at double or triple poles to be determined. Knowledge of all the residues enables the inverse Laplace transform of $f(z)$ to be constructed.

Calculations can also be carried out on functions of other types; in general, any regular function satisfies Laplace's equation and is capable of similar physical interpretation, though not always by using point electrodes only. For example, a branch cut may be simulated by a strip, made of conducting or insulating material, depending upon the type of discontinuity possessed by the function, placed in the electrolyte.

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Measurement of Diversity

THE 'characteristic' defined by Yule[1] and the 'index of diversity' defined by Fisher[2] are two measures of the degree of concentration or diversity achieved when the individuals of a population are classified into groups. Both are defined as statistics to be calculated from sample data and not in terms of population constants. The index of diversity has so far been used chiefly with the logarithmic distribution. It cannot be used everywhere, as it does not always give values which are independent of sample size; it cannot do so, for example, when applied to an infinite population of individuals classified into a finite number of groups. Williams[3] has pointed out a relationship between the characteristic and the index of diversity when both are applied to a logarithmic distribution. The present purpose is to define and examine a measure of concentration in terms of population constants.

Consider an infinite population such that each individual belongs to one of Z groups, and let $\pi_1 \ldots \pi_Z$ ($\Sigma\pi = 1$) be the proportions of individuals in the various groups. Then λ defined as $\Sigma\pi^2$ is a measure of the concentration of the classification. It can take any value between $1/Z$ and 1, the former representing the smallest concentration or largest diversity possible with Z groups, and the latter complete concentration, all the individuals being in a single group. λ can be simply interpreted as the probability that two individuals chosen at random and independently from the population will be found to belong to the same group.

Now suppose a sample of N individuals to be chosen at random from a population of this kind, and let $n_1, n_2 \ldots n_Z$ ($\Sigma n = N$) be the numbers of individuals falling into the various groups. It is easily shown that $l = \dfrac{\Sigma n(n-1)}{N(N-1)}$ is an unbiased estimator of λ; this is almost obvious since $\frac{1}{2}N(N-1)$ is the number of pairs in the sample and $\frac{1}{2}\Sigma n(n-1)$ is the number of pairs drawn from the same group.

l is also an unbiased estimate of λ when the sample-size varies, provided no samples of size 0 or 1 are included and that the probability of the sample $(n_1, n_2 \ldots n_Z)$ splits into these two factors:

$$P(n_1, n_2 \ldots n_Z) = P(N) \frac{N\,!}{n_1\,!\; n_2\,! \ldots} (\pi_1)^{n_1} (\pi_2)^{n_2} \ldots,$$

where $P(N)$ gives the probability distribution of the sample size, $2 \leqslant N \leqslant \infty$. This is true in particular when samples are obtained by the 'fixed-exposure' method common in biological work, N having then a Poisson distribution adjusted for the absence of the first two terms.

If repeated samples of size N are drawn from the same population, the values of l obtained will be distributed about λ with variance

$$\frac{4N(N-1)(N-2)\,\Sigma\pi^3 + 2N(N-1)\,\Sigma\pi^2 - 2N(N-1)\,(2N-3)\,(\Sigma\pi^2)^2}{[N(N-1)]^2},$$

or, if N be very large, approximately

$$\frac{4}{N}\,[\Sigma\pi^3 - (\Sigma\pi^2)^2].$$

The third and fourth cumulants of the distribution of l have also been calculated exactly. They indicate that as N increases, the distribution tends to normality except when $\lambda = 1/Z$; in that case the distribution of lNZ tends to that of χ^2 with $Z - 1$ degrees of freedom, but with its mean moved from $Z - 1$ to N.

The characteristic defined by Yule[1] is, in the notation used above, $1{,}000\ \Sigma n(n-1)/N^2$, which differs from l, the sample estimator of λ, only in having N instead of $N - 1$ in the denominator and in the scale factor of 1,000.

Now let us see what value λ takes for a population containing Z groups the frequencies of which are $\pi_i = w_i/\Sigma w$, where the w_i are chosen at random and independently from the Type III distribution

$$dF = \frac{1}{(k-1)\,!}\, e^{-w}\, w^{k-1}\, dw, \qquad 0 \leqslant w \leqslant \infty.$$

This may be called a 'negative binomial population', since samples drawn from it by the 'fixed exposure' method will obey the negative binomial distribution. The value of λ appropriate to it is obtained by averaging $\Sigma w_i^2/(\Sigma w_i)^2$ over all sets $(w_1, w_2 \ldots w_Z)$ which can be drawn from the population of values of w. Thus

$$\lambda = \int_0^\infty \cdots \int_0^\infty \left[\frac{1}{(k-1)\,!}\right]^Z e^{-\Sigma w}\, [w_1 \ldots w_z']^{k-1}\, \frac{\Sigma w_i^2}{(\Sigma w_i)^2}\, dw_1 \ldots dw_Z = \frac{k+1}{Zk+1}.$$

The Poisson distribution is the special case of the negative binomial distribution in which k tends to infinity. Under this condition, $\lambda = 1/Z$. This is as we would expect, since the Poisson distribution arises from a population in which all groups are equally represented, and so the probability that two individuals chosen at random will be found to belong to the same group must be $1/Z$.

The other extreme case of the negative binomial is the logarithmic population, which is obtained by letting Z tend to infinity and k tend to zero simultaneously so that the product Zk remains finite and tends to a quantity called α. (This is not quite the same derivation as that used by Fisher[2], but the quantity α is the same as his index of diversity.) The value obtained for λ under this limiting process is $1/(\alpha + 1)$.

It will be noticed that this last value is not consistent with the equation given by Williams[3], namely, that Yule's characteristic had the value $1{,}000/\alpha$ when applied to the logarithmic distribution. His result was obtained by applying Yule's formula to a series of expected values, whereas the present procedure is equivalent to applying the formula first and then averaging the result. Some support for the new equation is found by considering the ranges of the variables concerned. Since the characteristic cannot exceed 1,000, the earlier equation would deny to α all values less than 1; but the present one allows it the range $0 \leqslant \alpha \leqslant \infty$, while $1 \geqslant \lambda \geqslant 0$.

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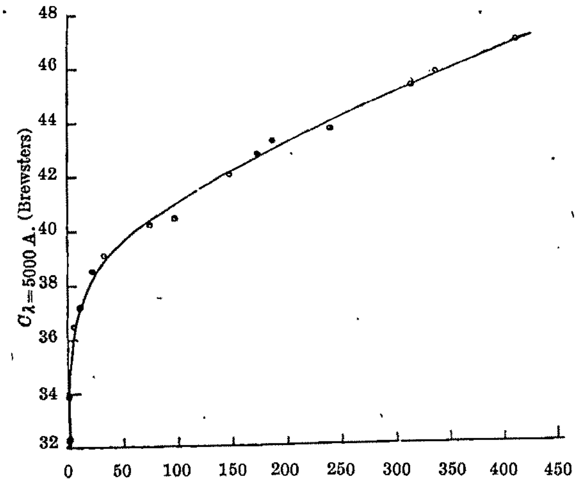
Photo-elastic Creep in 'Catalin 800' and *CR* 39

DURING the course of an investigation on the variation with wave-length λ of the stress-optic coefficient C_λ of 'Catalin 800' (a glass-clear phenol-formaldehyde resin) and of *CR* 39 (a condensed allyl ester), it has been found that C_λ depends upon the time allowed to elapse between the application of the load and the measurement of the resultant birefringence, the effect being due to the so-called photo-elastic creep in the loaded specimens. The two specimens, one of 'Catalin' and the other of *CR* 39, were both strained by a tensile force applied by a simple loading machine working on the lever principle, and the stress-optic coefficients were determined by the modified form of Filon's method[1], using a spectrograph instead of the usual spectrometer.



O—O—, Experimental points; curve computed from $C_\lambda = c_0' + c_1' \{1 - \exp(-kt^{1/3})\} + c_2't$

From the spectrogram formed by plane-polarized parallel light which has passed through a narrow limited section of the strained specimen, C_λ for a given wave-length can be deduced. From a series of such spectrograms, taken at intervals of time, t, after loading, values of C_λ for $\lambda = 5000$ A. were calculated, and plotted against t. Equations were itted to the curves.

For 'Catalin' the results agree with those of Mylonas[2], the relation between C_λ and t being

$$C_\lambda = c_0 + c_1 t^{0\cdot 3}, \qquad (1)$$

where c_0 and c_1 are constants. The maximum duration of the test was 24 hours, though Mylonas, who originally suggested (1), used tests of duration less than one hour. For periods of continuous loading up to one hour, the experimental results agree with 1) to within 1 per cent, and for periods of 24 hours to within 5 per cent. c_0 and c_1 vary considerably from test to test, appearing to depend upon the history of the specimen. (A similar effect has been observed by previous investigators but for other materials.) Since the same value of load was used hroughout, the dependence, if any, of c_0 and c_1 on he stress could not be ascertained.

For *CR* 39 more detailed results were obtained, but, as for 'Catalin', for one value of load only. The 'creep'-rate was not as rapid as for 'Catalin'. For short-period loadings, C_λ and t are related exponentially, but for long-period loading (over a range of 400 hr.) a better fit to the experimental results is given by

$$C_\lambda = c_0' + c_1' [1 - \exp(-kt^{1/3})] + c_2't \qquad (2a)$$

for $\lambda = 5000$ A., where c_0', c_1' and c_2' are constants and t is in hours; k is numerically of the order of 0·32. After 450 hours, the observed values of C_λ were less than those given by (2a), and it is probable that the linear term $c_2't$ should be replaced then by another exponential term. For short-period loading it is clear that (2a) reduces to

$$C_\lambda = c_0' + c_1' [1 - \exp(-kt^{1/3})], \qquad (2b)$$

since c_0', c_1' and c_2' are of the order of 30 and 9 Brewsters, and 0·015 Brewsters per hour respectively. It is interesting to note that a relationship of the form of (2b) was originally suggested by Pierce[3] in connexion with the variation of the torsion of a cotton thread with time.

In the past, investigators have found a similarity between optical and mechanical 'creep' behaviours in various materials. A brief check of the mechanical 'creep' properties of 'Catalin' or *CR* 39, by measuring the deflexions of beams of the two materials when subjected to a constant bending moment, was made. Relations approximately analogous to those of (1) and (2b) were obtained.

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Amino-Acid Composition of Salmine

A DETAILED chemical analysis of the amino-acid composition of salmine (from a commercial source) was presented by Block and Bolling[1], who used chemical and microbiological techniques. The amino-acids found were arginine, alanine, *iso*leucine, proline, serine and valine. Tristram[2] confirmed the presence of these, and in addition demonstrated that glycine was also a constituent.

In the course of other work, analyses have been made in this Laboratory of hydrolysed salmine (commercial) by partition chromatography on paper. The 'ascending' modification of the original method was used[3]. We thought it of interest to report that our results confirmed those of Tristram. No other amino-acids were detected using one- or two-dimensional chromatograms when phenol with ammonia, collidine–lutidine mixture 1 : 1 (v/v), or *n*-butanol–acetic acid mixture 4 : 1 (v/v), were used as solvents.

An estimate of the proportions of amino-acids present has been made by the spot-dilution technique[4]. The results are presented in the accompanying table.

	Amino-acid per 100 gm. salmine		
Amino-acid	Authors	Tristram	Block
Arginine	87·5	85·2	88·4
Alanine	0·6	1·10	3·6
Glycine	3·6	2·94	—
*iso*Leucine	1·8	1·61	1·5
Proline	5·0	5·8	7·9
Serine	5·6	9·1	7·0
Valine	3·8	3·1	4·1

The proportions found were in fair agreement with those of the earlier workers; but appreciably lower values were obtained for the amounts of alanine and serine. The hydrolysis was carried out by heating the salmine in a sealed tube with 5N hydrochloric acid for 40 hr. at 90° C. The low values observed in the case of alanine and serine do not appear to be attributable either to incomplete hydrolysis or to destruction during digestion, because (*a*) the results were not altered by considerably longer periods of hydrolysis, and (*b*) chromatograms of a mixture of the seven amino-acids before and after treatment, under the conditions of the hydrolysis, showed no detectable destruction of any component.

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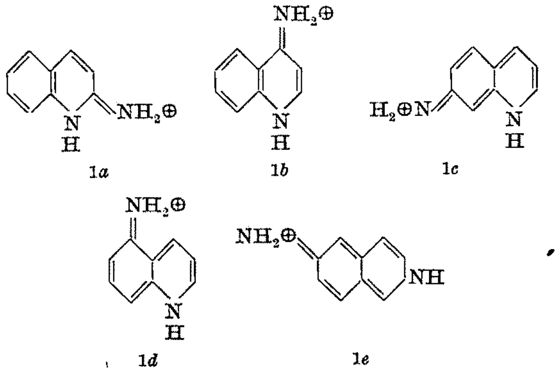
Base-Strengthening Effect of Resonant Amino Groups in some Heterocyclic Bases

IT was shown by Albert and Goldacre[1] that an amino group substituted in a 'resonant position' of a six-membered aromatic heterocyclic base results in a compound of enhanced basic strength. This is attributed to the replacement of a dipolar resonant form by a more stable homopolar resonant form.

The ionic quinonoidal structures discussed by Albert and Goldacre[1] fall into four groups: (1) an *ortho*-quinonoid structure, as represented by 2-amino quinoline (Fig. 1*a*); (2) a *para*-quinonoid structure, as represented by 4-amino quinoline (Fig. 1*b*); (3) an *ortho-para*-quinonoid structure, as represented by 7-amino quinoline (Fig. 1*c*); (4) an *ortho-ortho*-quinonoid structure, as represented by 5-amino quinoline (Fig. 1*d*). A fifth possibility, that of a *para-para*-quinonoid structure, was not considered by them. The simplest example of this type would be 6-amino *iso*quinoline (Fig. 1*e*).



1*a* 1*b* 1*c* 1*d* 1*e*

Fig. 1

It seemed of interest to determine the base-strengthening effect (ΔpK_A) of such a *para-para*-quinonoid structure, in order that a comparison of the relative stabilities of the above five structures can be made. For this purpose 2-amino benzcinnoline (Fig. 2) was chosen, 6-amino *iso*quinoline being unavailable.

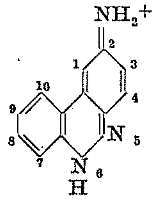


Fig. 2

The pK_A of benzcinnoline and of its 2-amino derivative was determined, in water by the colorimetric method described by Albert and Goldacre[2], and in 50 per cent ethanol by potentiometric titration (glass-electrode). The results are expressed in Table 1.

Table 1

	Water		50% ethanol	
	Conc.	pK_A (20°)	Conc.	pK_A (20°)
Benzcinnoline	0·0002 M	2·20 ± 0·05	0·05 M	1·6 ± 0·2
2-Amino benzcinnoline	0·0002 M	6·68 ± 0·05	0·006 M	6·23 ± 0·05
ΔpK_A		4·48 ± 0·1		4·6 ± 0·2

The base-strengthening effects of amino groups substituted in those positions associated with quinonoidal resonances of the above five types, measured in water, are listed in Table 2.

Table 2. ΔpK_A effects* of quinonoidal resonances

Nucleus	Quinonoidal structure				
	ortho-	*para-*	*ortho-para-*	*ortho-ortho-*	*para-para-*
Pyridine	1·63	3·94	—	—	—
Quinoline	2·40	4·23	1·71	0·52	—
*iso*Quinoline	2·29	—			
Acridine	—	4·39	2·44	0·44	—
3 : 4-Benzacridine	—		2·72		—
Pyridazine	2·86		—	—	—
Pyrimidine	2·24	4·41	—	—	—
Pyrazine	2·54	—	—	—	—
Cinnoline	—	4·14			
Phthalazine	3·13	—		—	
Quinazoline	0·92†	2·22†			
Quinoxaline	3·16	—			—
3 : 4-Benzcinnoline	—	—			4·48

* Values (water) calculated from Albert, Goldacre and Phillips[3].
† The anomalous values for quinazoline will be discussed in a futur note by one of us (J. N. P.).

From Table 2 it can be seen that the ΔpK associated with any particular quinonoidal structur is reasonably constant for several heterocyclic nucle (It is interesting to note, in view of the great differences in water solubility of the compounds in Tabl 2, that solvation seems to play only a minor part. The constancy of pK_A suggests that the resonanc energy of such a structure is the predominant facto in determining the basic strength. The relativ stability of the five structures is seen to be

para- and *para-para-* > *ortho-* and *ortho-para-* > *ortho-ortho-*.

Since the presence of fused benzene rings does no appreciably influence the ΔpK_A, then from the abov postulate that a *para-para*-quinonoid is of the sam order of stability as a *para*-quinonoid structure, i would follow that a *para*-quinonoid and an isolate Kekulé structure are of approximate total energ equivalence. The fact that the *ortho-* and *ortho-para* quinonoid types show the same order of stabilit supports this conclusion. It can similarly be reasone that an *ortho*-quinonoid structure is of greater tot energy (less stability) than an isolated Kekulé structure.

The figures in Table 2 enable one to predict approximate pK_A values (in water) for bases giving rise to ionic forms of the above five types. ΔpK_A values (averaged from Table 2) would be *ortho* = + 2·5, *para* = + 4·2, *ortho-para* = + 2·3, *ortho-ortho* = + 0·5, *para-para* = + 4·5.

In this way, from the pK_A values of *iso*quinoline (5·33, water), phthalazine (3·47, water) and phenanthridine (3·30, 50 per cent ethanol), the pK_A values of 6-amino *iso*quinoline, 6-amino phthalazine and 6-amino phenanthridine may be predicted to be 9·8 (water), 8·0 (water) and 7·9 (50 per cent ethanol; see Table 1 for ΔpK_A), respectively. These three bases (*para-para*-quinonoid type) would be the strongest mono-amino derivatives in their series, since in each case no amino derivative of the *para*-quinonoid type is possible.

One of us (P. H. G.) thanks the Commonwealth Research Grant Committee of this University for a scholarship.

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Oct. 6.

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Reaction between Hydrogen Peroxide and Iron Salts

FROM a recent discussion with J. H. Baxendale and P. George, we understand that they have from kinetic studies proposed a reaction scheme for the mechanism of the evolution of oxygen from hydrogen peroxide and ferrous ions [see p. 692 of this issue of *Nature*]. We have also obtained experimental evidence from the studies of the consumption ratios which lead to conclusions similar to theirs and which are discussed in the following.

The reaction between hydrogen peroxide and ferrous salts has been studied by Haber and Weiss[1] and certain aspects of it more recently again by Baxendale, Evans and Park[2]. We have now studied this reaction in its dependence on *p*H, and we have investigated the role of the ferric ions in the hydrogen peroxide ferrous-ion reaction.

We have used a flow apparatus built on similar lines to those suggested by Schmid[3], to bring about a very rapid mixing of the component solutions and thus to ensure well-defined initial concentrations of the reactants. So far, only consumption ratios $(-\Delta(H_2O_2)/-\Delta(Fe^{II}))$ have been measured.

In order to study the effect of ferric ions, we have investigated the reaction (at different *p*H) in the presence of (i) fluoride, (ii) pyrophosphate ions, both of which are known to form stable complexes with ferric ions, and we have convinced ourselves that these complexes are not active as catalysts. We have found that fluoride and pyrophosphate ions both decrease the consumption ratios.

It is of importance to note that the hydrolysis products of ferric ions (which are formed if the reaction is carried out at sufficiently high *p*H) are themselves also practically inactive as catalysts during time intervals which are relevant for the relatively fast reaction between ferrous ions and hydrogen peroxide.

Conversely, we have been able to show that addition of ferric salts (over and above that formed by the oxidation of the ferrous salt) increases the consumption ratios. This clearly indicates that ferric ions are involved in the ferrous ion catalysis, which, however, must not be confused with the well-known relatively slow catalytic decomposition of hydrogen peroxide by ferric salt alone.

It seems that all this can be explained by a slight modification of the original scheme of Haber and Weiss by introducing into the 'ferrous ion catalysis' one of the reactions (reaction (14) of ref. 1) which has been considered previously in connexion with the 'ferric ion catalysis'.

The decrease of the consumption ratios with decreasing *p*H suggests further that it is the anion, O_2^-, rather than the undissociated HO_2 which enters into the reaction, the two being connected by the equilibrium $HO_2 \rightleftharpoons H^+ + O_2^-$.

Thus in addition to the original equations:

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + OH \ldots (1)$$

$$H_2O_2 + OH \rightarrow H_2O + HO_2 \ldots\ldots\ldots\ldots (2)$$

$$H_2O_2 + HO_2 \rightarrow O_2 + H_2O + OH \ldots\ldots (3)$$

$$Fe^{2+} + OH \rightarrow Fe^{3+} + OH^- \ldots\ldots\ldots\ldots (4)$$

with a possible additional chain-breaking by the interaction of two radicals, for example:

$$HO_2 + OH \rightarrow O_2 + H_2O, \ldots\ldots\ldots (5)$$

one has the oxygen-producing reaction:

$$Fe^{3+} + O_2^- \rightarrow Fe^{2+} + O_2; \ldots\ldots (6)$$

which reaction, in the presence of ferric ions, largely replaces reaction (3); this, on the other hand, is of fundamental importance in the photochemical decomposition[4] and in the decomposition of hydrogen peroxide by ionizing radiations[5].

Reaction (6) is also of great importance in the aerobic oxidation of ferrous ions, as discussed previously[6].

If, on the other hand, one starts with ferric ions only, the initial reaction is represented by the well-known process[1]:

$$Fe^{3+} + HO_2^- \rightleftharpoons Fe^{2+} + HO_2 \ldots\ldots (7)$$

which, in conjunction with the oxygen-producing reaction (6) and followed by the re-oxidation of the ferrous ions according to reactions (1) and (4), gives a sufficiently complete picture of the 'ferric ion catalysis' of hydrogen peroxide as discussed in the earlier paper[1]. However, in general one has to include also the reverse process of reaction (7) and the chain reactions (2) and (3) as discussed previously.

Thus the only difference compared with the previous scheme is that reaction (6) preponderates over reaction (3) if ferric ions are present.

A full account with all the experimental details will be published elsewhere.

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REACTIONS OF FERROUS AND FERRIC IONS WITH HYDROGEN PEROXIDE

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In the elucidation of the mechanism of the reactions between hydrogen peroxide and ferrous and ferric ions, a considerable advance was made by Haber and Weiss[1], who suggested that the highly reactive intermediates which have been shown to be present were the radicals $HO\cdot$ and HO_2. Their mechanisms, recently revised by Weiss[2], are as follows:

Fe^{2+} reaction

$$\begin{array}{llll} Fe^{2+} + H_2O_2 & \rightarrow Fe^{3+} & + OH^- & + HO. \\ H_2O_2 + HO\cdot & \rightarrow H_2O & + HO_2 & \\ H_2O_2 + HO_2 & \rightarrow O_2 & + H_2O & + HO. \\ Fe^{2+} + HO_2 & \rightarrow Fe^{3+} & + HO_2^- & \\ Fe^{2+} + HO\cdot & \rightarrow Fe^{3+} & + OH^- & \end{array}$$

Fe^{3+} reaction

$$\begin{array}{llll} H_2O_2 & \rightarrow H^+ & + HO_2^- & \\ Fe^{3+} + HO_2^- & \rightarrow Fe^{2+} & + HO_2 & \\ H_2O_2 + HO_2 & \rightarrow O_2 & + H_2O & + HO\cdot \\ Fe^{2+} + HO\cdot & \rightarrow Fe^{3+} & + OH^- & \\ OH^- + H^+ & \rightarrow H_2O & & \end{array}$$

The reaction with the ferrous ion is seen to involve chains with $HO\cdot$ and HO_2 as carriers; the ferric ion reaction consists of a sequence of radical reactions. In both cases oxygen is evolved by HO_2 reacting with hydrogen peroxide.

We have made an extensive experimental investigation which has revealed several new facts incompatible with the above scheme for the ferrous ion reaction. We conclude that the reaction producing oxygen is not that of HO_2 with hydrogen peroxide, but HO_2 or O_2^- with the ferric ion, and we propose a chain reaction involving HO_2, $HO\cdot$ and Fe^{2+} as carriers. The same chain mechanism will interpret satisfactorily both the ferrous and the ferric reactions.

The following is a summary of our observations on the ferrous ion reaction.

Ferrous Ion Reaction

It has previously been found that with low H_2O_2/Fe^{2+} ratios and in acid solutions the reaction is second order and the overall stoichiometry is $2Fe^{2+} \equiv H_2O_2$. When an excess of a polymerizable vinyl compound is present, the reaction is still second order in ferrous ion and hydrogen peroxide, but the stoichiometry changes to $Fe^{2+} \equiv H_2O_2$. Under these conditions polymerization occurs and the polymer has terminal hydroxyl groups. These observations are good evidence that the following reactions occur[3]:

$$\begin{array}{llll} Fe^{2+} + H_2O_2 & \rightarrow Fe^{3+} & + OH^- + HO\cdot & (o) \\ Fe^{2+} + HO\cdot & \rightarrow Fe^{3+} & + OH^- & (1) \\ M \quad + HO\cdot & \rightarrow HOM\cdot & \rightarrow \text{polymer} & \end{array}$$

In the absence of substrate the rate equation is

$$-d[Fe^{2+}]/dt = 2k_0[Fe^{2+}][H_2O_2].$$

However, although at low H_2O_2/Fe^{2+} ratios monomers are polymerized, leuco dyestuffs oxidized to the dye, and certain dyes destructively oxidized, thus confirming the presence of the radical HO, we have found that at the same concentrations of ferrous ion and substrate these reactions do not occur with high concentrations of hydrogen peroxide.

It is clear that under these conditions another competitor for $HO\cdot$ is present, and the observations can be explained if $HO\cdot$ reacts with hydrogen peroxide to give HO_2. The HO_2 radical thus formed is apparently unable to open the double bond of a vinyl compound or to oxidize the other substrates.

With high H_2O_2/Fe^{2+} ratios, oxygen is evolved on the addition of ferrous ion to hydrogen peroxide, which means that the stoichiometry is no longer $2Fe^{2+} \equiv H_2O_2$ and other reactions enter in addition to (o) and (1) above. The following results obtained in perchloric acid solutions from *p*H 1 to *p*H 3 enable the mechanism of reaction in this *p*H range to be deduced.

(1) *Ferrous Ion Kinetics.* With concentrations of ferrous ion of approximately 10^{-5} *M* and hydrogen peroxide less than 10^{-3} *M*, $d[Fe^{2+}]/dt$ can be measured by determining the concentration of ferrous ion, $[Fe^{2+}]$, colorimetrically with dipyridyl. Peroxide can be estimated by adding to excess acid Fe^{2+} or as pertitanic acid. Provided $2[Fe^{2+}] > [H_2O_2]$ initially, the reaction is second order throughout with $2Fe^{2+} \equiv H_2O_2$. This holds up to *p*H 3. At high H_2O_2/Fe^{2+} ratios the reaction initially follows the normal second-order course; but the 'rate constant' $k_{obs.}$ decreases as the reaction proceeds. This effect is shown in Fig. 1, curves (*a*) and (*b*), where the results are plotted as for a second-order reaction with hydrogen peroxide in great excess. Values of $k_{obs.}$ which are less than half that of the overall normal constant $2k_0$ are obtained. For a given

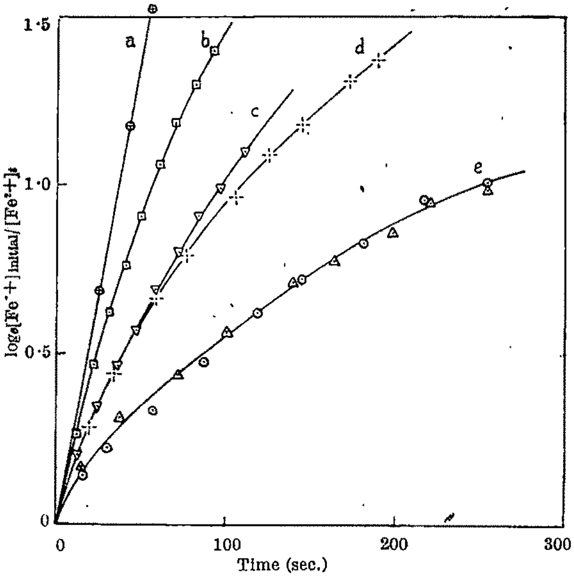

Fig. 1. Course of $Fe^{2+} + H_2O_2$ reaction with initial concentrations $1\cdot4 \times 10^{-5}$ Fe^{2+} and $29\cdot5 \times 10^{-5}$ *M* H_2O_2 at 25° C., and *p*H 2·65 except in (*a*). In no case is more than 10 per cent of the hydrogen peroxide used over the time interval shown. (*a*) *N*/2 $HClO_4$; (*b*) no additions; (*c*) initially $4\cdot6 \times 10^{-5}$ *M* Fe^{3+}; (*d*) initially $1\cdot4 \times 10^{-6}$ *M* Cu^{2+}; (*e*) initially $2\cdot4 \times 10^{-3}$ (△) and $1\cdot2 \times 10^{-3}$ *M* Fe^{3+} (⊙)

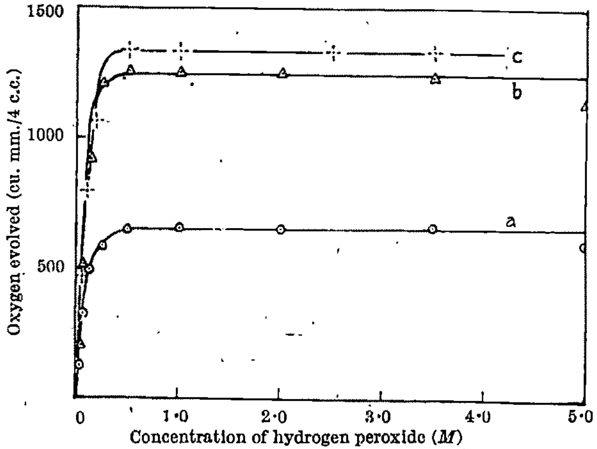

Fig. 2. Oxygen evolution from the reaction $Fe^{2+} + H_2O_2$ at various concentrations of hydrogen peroxide. (*a*) *p*H 1·5 ; (*b*) *p*H 1·8 ; (*c*) *p*H 1·5 with 4×10^{-2} *M* Fe^{3+} initially. Initial Fe^{2+}, 4×10^{-3} *M* in each case

initial concentration of ferrous ion, these deviations from second order increase with hydrogen peroxide concentration until eventually the effect of increasing the peroxide reaches a limit. This is paralleled by the dependence on the peroxide concentration of the total amount of oxygen evolved as the ferrous ions are oxidized to ferric ions given in (2) below.

Moreover, the course of a reaction from any time *t* onwards can be reproduced *ab initio* only with solutions of the same concentrations of hydrogen peroxide, ferrous ions and *also* ferric ions as at time *t*, but *not* with solutions containing the same concentrations of peroxide and ferrous ions alone.

(2) *Oxygen Evolution.* The total amount of oxygen evolved as the ferrous ion is oxidized to the ferric is easily determined from an oxygen evolution – time plot by extrapolating the linear portion, due to the subsequent catalysis of ferric ions back to zero time[4]. Above a certain H_2O_2/Fe^{2+} ratio it is found to be independent of the concentration of hydrogen peroxide and varies approximately inversely with the concentration of hydrogen ions over the range *p*H 1–2 (Fig. 2 (*a*) and (*b*)).

(3) *Effect of Ferric or Cupric Ions.* If ferric ions are added to a reaction mixture, the total oxygen evolved as ferrous ions are oxidized is greatly increased, and $k_{obs.}$ is less than 2 k_0 even at the beginning of a reaction. The same effect is observed with cupric ions, with the striking difference that the cupric ion is more efficient than the ferric (see Figs. 1 (*c*) and (*d*) and 2 (*c*)). This effect at first increases with increase of ferric or cupric ion ; but we find that for any given concentration of hydrogen peroxide and ferrous ion, the evolution of oxygen and deviations from second-order reaction are unaffected by further additions of ferric or cupric ions beyond a certain amount (see Fig. 1 (*e*)). In addition, at H_2O_2/Fe^{2+} ratios where the evolution of oxygen is normally independent of the concentration of hydrogen peroxide, it increases with the latter when these limiting amounts of ferric or cupric ions are present. Similarly, the limiting deviations from second order at high concentrations of hydrogen peroxide described in (1) above are no longer observed at sufficiently high concentrations of ferric and cupric ions.

(4) *Effect of Fluoride Ions.* In the presence of fluoride ions, the total evolution of oxygen is decreased, and a system which would have shown deviations from second-order kinetics no longer does so.

From the observations described in (1)–(4), we conclude that : (*a*) The oxygen is *not* evolved as the result of a reaction between HO_2 and hydrogen peroxide, with a terminating reaction between ferrous ions and $HO\cdot$ or HO_2. In these cases, it would always increase with the concentration of hydrogen peroxide, whereas we find it reaches a limiting value.

(*b*) The oxygen is evolved in a reaction involving ferric (or cupric) ions. This is probable because of the increase obtained by addition of these ions, and the decrease when ferric ions are removed by fluoride.

(*c*) Ferrous ions are regenerated by the oxygen evolution reaction. This is probable because we have found that at high H_2O_2/Fe^{2+} ratios, $k_{obs.}$ can be much less than k_0, the value it would have if all reactions involving ferrous ions, other than the primary step (*o*) above, were eliminated (see ref. 3). Hence ferrous ions must be regenerated during the reaction. Further, $k_{obs.}$ is even smaller, and thus ferrous ions are regenerated more rapidly when ferric (or cupric) ions are present initially, that is, under the conditions for increased oxygen evolution. The most probable reaction to account for these observations is one between Fe^{3+} or Cu^{2+} and HO_2.

(*d*) Another reaction which removes ferrous ions occurs in addition to reaction (1) above. This is required because the qualitative experiments with substrates suggest that most $HO\cdot$ reacts with hydrogen peroxide at high H_2O_2/Fe^{2+} ratios, and hence $Fe^{2+} + HO\cdot$ is no longer a significant reaction. But in spite of this, the ferrous ions are still removed initially at a rate which corresponds to that at low H_2O_2/Fe^{2+} ratios, that is, $k_{obs.}$ is always initially equal to 2 k_0 in the absence of added ferric ions. The kinetics can be accounted for if the additional reaction is between ferrous ions and HO_2.

Reaction Scheme. From these considerations we propose the following reaction scheme :

$$\begin{array}{llll}
Fe^{2+} + H_2O_2 & \rightarrow Fe^{3+} + OH^- + HO\cdot & k_0 & (o) \\
Fe^{2+} + HO\cdot & \rightarrow Fe^{3+} + OH^- & k_1 & (1) \\
H_2O_2 + HO\cdot & \rightarrow H_2O + HO_2 & k_2 & (2) \\
Fe^{2+} + HO_2 & \rightarrow Fe^{3+} + HO_2^- & k_3 & (3) \\
Fe^{3+} + HO_2 & \rightarrow Fe^{2+} + O_2 + H^+ & k_4 & (4)
\end{array}$$

At very low H_2O_2/Fe^{2+} ratios, only steps (*o*) and (1) occur, the reaction is second order and the evolution of oxygen is zero. As the ratio increases, the course of reaction is determined by competition for $HO\cdot$ in (1) and (2); hence the evolution of oxygen and deviations from second-order kinetics increase with the concentration of hydrogen peroxide. At high H_2O_2/Fe^{2+} ratios, the competition for HO_2 in (3) and (4) predominates, and since these do not involve hydrogen peroxide, the oxygen evolved and the kinetic deviations become independent of the concentration of hydrogen peroxide. The effect produced by cupric ions can be explained if they react more readily than ferric ions in (4), and we have

$$\begin{array}{ll}
Cu^{2+} + HO_2 \rightarrow Cu^{+} + O_2 + H^+ & (5) \\
Cu^{+} + Fe^{3+} \rightarrow Cu^{2+} + Fe^{2+} & \text{(very fast).}
\end{array}$$

These two reactions amount to a catalysis of reaction (4). The limiting conditions attained in the presence of ferric or cupric ions are seen to arise when (4) or (5) predominate to such an extent that HO_2 termination in (3) is no longer significant compared with $HO\cdot$ termination in (1). Under these conditions, the total oxygen evolved and $k_{obs.}$ should again be dependent on the concentration of hydrogen peroxide as observed.

The kinetics of the reaction and the amount of oxygen evolved are found to agree with the expressions which can be deduced from the above mechanism, and, from the kinetic analysis, values for k_4/k_3 and k_1/k_2 can be obtained. These will be discussed in a later publication. We find that k_1/k_2 is independent of pH, whereas $k_4/k_3 = \frac{K}{[H^+] + K_1}$ over the range examined. K_1 is found to be about 6×10^{-3}, which corresponds closely to the equilibrium constant of[5]

$$Fe^{3+} + H_2O \rightleftharpoons FeOH^{2+} + H^+.$$

The variation of k_4/k_3 with the concentration of hydrogen ions can be accounted for if the reactants in (3) and (4) are

(i) $Fe^{2+} + HO_2$, and $Fe^{3+} + O_2^-$
or (ii) $Fe^{2+} + HO_2$, and $FeOH^{2+} + HO_2$
or (iii) $Fe^{2+} + O_2^-$, and $FeOH^{2+} + O_2^-$.

A detailed kinetic analysis shows that only the reactions in (i) occur.

Ferric Ion Reaction

The catalytic decomposition of hydrogen peroxide by ferric salts has been found to be first-order both with regard to hydrogen peroxide and ferric ions, and to vary inversely as the concentration of hydrogen ions[1]. This kinetic form can be obtained if the initial reaction is

$$Fe^{3+} + HO_2^- \rightarrow Fe^{2+} + HO_2 \ldots . ki, \qquad (i)$$

and is followed by reactions (*o*), (2), (3) and (4) in the ferrous ion scheme above. The exclusion of (1) is justified since these experiments have usually been done at high H_2O_2/Fe^{3+} ratios. This mechanism is to be preferred to that proposed by Weiss[2] because it retains reactions which are necessary to explain the ferrous ion reaction, and which cannot be ignored in the ferric ion reaction. An important feature of the above scheme is that it is a chain reaction rather than a sequence of radical reactions as proposed by Weiss. Preliminary calculations using the constants derived from the study of the ferrous ion reaction indicate a chain-length of about 10^3.

A recent investigation of the ferric ion reaction by Andersen[6] shows that at *low* H_2O_2/Fe^{3+} ratios the reaction is no longer first order with regard to hydrogen peroxide, but somewhat higher. The data of Simon *et al.* show similar features[7]. The higher order can be understood if at these low H_2O_2/Fe^{3+} ratios reaction (1) becomes significant, for if (1) *completely* replaces (3), as a chain termination reaction, the decomposition-rate is given by

$$-d[H_2O_2]/dt = k\,[Fe^{3+}]^{1/2}\,[H_2O_2]^{3/2}. \qquad (6)$$

The well-established promotion by cupric ions of the ferric ion catalysed decomposition of hydrogen peroxide, which has been examined in some detail by Bohnson and Robertson[8], gives further support. They observed a limiting promotion effect by cupric ions which is similar to that described above in the ferrous ion reaction and can be explained in the same way, namely, by the predominance of reaction (5) over (3), causing all chain termination to occur by reaction (1), thus making the overall reaction independent of the concentration of cupric ions. Furthermore, the predicted rate expression in these conditions is the same as (6) above, and this is supported by the data available in that they show a dependence of the rate on the square root of the concentration of ferric ions, $[Fe^{3+}]^{1/2}$.

These ferric ion reactions are being investigated in more detail to check the above kinetic expressions.

We are indebted to Prof. M. G. Evans for advice and helpful discussions during the course of this work.

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THE RARE ISOTOPE OF HELIUM, He^3; A KEY TO THE STRANGE PROPERTIES OF ORDINARY LIQUID HELIUM, He^4

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A very interesting experiment with the rare helium isotope helium-3 has recently been made by D. W. Osborne, B. Weinstock and B. M. Abraham, of the Argonne National Laboratory in Chicago[1]. This experiment is crucial, as it may decide the correctness of a theory devised eleven years ago[2] to explain the peculiar properties of the fluid into which ordinary liquid helium turns when cooled below the temperature of 2·19° abs. (about two degrees below its normal boiling point of 4·2° abs.).

Above 2·19° abs., liquid helium behaves very much like any other liquid; it shows ordinary viscous flow, normal heat conductivity, etc. At 2·19° abs. it undergoes a strange change of state; its entropy, that is, its degree of thermal disorder, very rapidly decreases within a small temperature-range with a discontinuity of the specific heat at 2·19° abs. (λ-point). However, instead of solidifying as any other liquid would do if cooled to a sufficiently low temperature, liquid helium turns, below 2·19° abs., into a very peculiar kind of fluid, which has characteristically been called 'superfluid'. It no longer has an ordinary viscosity, it leaks through the finest cracks which were practically tight for helium, liquid or gaseous, above 2·19°. It shows a particular transfer of heat with a facility incomparably better than any other substance. One speaks of 'heat-superconductivity'. In addition, there are many other utterly strange features by which liquid helium below 2·19° abs., called 'liquid helium II', is distinguished from all other known liquids.

The theory proposed by me in 1938 tried to relate the unique properties of liquid helium II to those of what one calls an 'ideal Bose–Einstein gas'. In 1924, Einstein[3], generalizing ideas of the Indian physicist Bose, had developed a very strange concept of a gas consisting of identical molecules, which are assumed to be in a very radical sense indistinguishable from each other. He conceived that it should not only be impossible to distinguish a case (I) where molecule A is here and molecule B is there from another case (II) where molecule B is here and molecule A is there, but that one should not even count these two indistinguishable cases, I and II, as two separate cases; rather they should be considered as *one single case* only. Einstein remarked that this kind of taking away the last vestige of individuality from the molecules of a species would lead to a curious "condensation phenomenon". Even disregarding the forces between the molecules, one would obtain a peculiar change of state of aggregation at a well-defined temperature; the molecules would 'condense' in a certain, though not in a crystallized, state. Einstein himself did not give a detailed proof, and his strange remark received little attention at that time. Most people considered it as a kind of oddity which had, at best, an academic interest, since at the extremely low temperature in question there are no gases, all substances eing frozen or at least condensed. In addition, oubt was cast on the mathematical correctness of instein's remark. Thus the matter was dealt with a sense as if there is no 'Bose–Einstein conden- ation'.

When the strange properties of superfluid helium ecame known, during 1937–38, I remembered the marks of Einstein on the 'Bose–Einstein con- ensation', and worked out the theory in more tail. In the meantime, from quite another source, mely, from spectroscopic observations with helium lecules, direct evidence has been found which uld only be interpreted by assuming that per- itations of helium atoms are, indeed, to be counted the way suggested by Einstein. Thus it happened at only at that time it was ascertained that an al Bose–Einstein gas would actually show a break the specific heat, c_p. In particular, for molecules of e molecular weight and the density of liquid helium, is break would occur at a temperature of 3·09° abs., ry close indeed to the 2·19° abs. of the transition mperature of liquid helium. Allowance should, of ourse, be made for the fact that the intermolecular rces have been entirely neglected in this calcula- on. Thus I concluded that the strange change state in liquid helium, even though manifested in e fluid and not in the gaseous state, might be due the same mechanism the skeleton of which is ready visible if one simplifies the liquid to the gree that one disregards the forces between the olecules entirely. In some way this peculiar ndensation can be described by saying that it presents a kind of ordering process, though not so ch with respect to the location of the atoms in ce (as happens to be the case for an ordinary ndensation or crystallization), but rather with pect to their velocities.

t proved too difficult, however, to substantiate s idea directly by including the effect of the eraction forces in the calculations. Nevertheless, nerous qualitative consequences could be deduced m this interpretation without entering into the ails of such difficult calculations; these conse- ences corroborated a general concept which is now own as the 'two-fluid model' of helium II and which to a series of predictions of phenomena with uid helium which were not known at that time which were afterwards verified by experiments. obably the farthest reaching implications were dis- ered by L. Tisza[4]. We met when I was developing the above ideas about the Bose–Einstein condensation and its possible relation to the transformation of liquid helium into superfluid helium. Almost immediately he saw that this picture would imply, among other consequences, a very peculiar heat transport in superfluid helium, entirely different from the cumbersome mechanism by which heat is ordinarily propagated in matter (namely, by heat conduction or convection). It was inferred that heat could go through superfluid helium by way of a new kind of waves very much as sound does, with, however, a different characteristic propagation velocity. The velocity of these peculiar waves would depend on the temperature: it would be zero at 2·19°, would increase to a maximum at about 1·6° abs., and then again decrease for still lower temperatures.

When Tisza made this prediction (1938), practically no one took the theory seriously. It appeared too queer that the mere non-individuality of molecules should have such a very concrete measurable consequence. Thus nobody cared to make an experiment at that time in order to see whether there was any truth in this idea. The War came, most physicists were busy with war physics, and the whole theory was almost forgotten, when in 1941, in Moscow, a similar theory was developed by L. Landau[5], not quite independently of the foregoing development. Yet he contested the idea that the Bose–Einstein statistics had anything to do with the subject—arguing that liquid helium is not a gas, which fact, of course, has never been questioned. Landau's theory was supposed to be based on a quantization of hydrodynamics, but actually it seemed much more to rest on newer measurements with liquid helium, which were made in Moscow by Kapitza at the same time[6]. Some of Kapitza's results had been implied in the predictions Tisza had made three years earlier on the basis of the Bose–Einstein theory. Hence they ought to be considered as confirmations of that theory.

Unfortunately, it was difficult to appreciate Landau's theory, as its theoretical basis appeared quite obscure. On the other hand, it has not been possible so far to develop a rigorous statistical theory of the liquid state which includes both the Bose–Einstein condensation and the interaction forces as well. Yet so far as the measurable phenomena are concerned, the mathematical scheme yielded by either of the two theories, London–Tisza's on one hand, and Landau's on the other, seemed essentially the same. In particular, the new kind of wave propagation appears in Landau's theory also; Landau called the new waves "second sound", not quite appropriately, since it is heat rather than pressure which is being propagated.

But Landau, being close to an excellent low-temperature laboratory, now gave the incentive for further experiments. They were conducted by Peshkov in Moscow near the end of the War[7]. These experiments brilliantly confirmed the existence of the predicted 'second sound', or rather thermal waves, in all details. In particular, they confirmed the values predicted by the theory for the propagation velocity of these peculiar waves for all temperatures measured.

This showed that the equations which described the behaviour of liquid helium II in bulk were essentially correct. Yet it appeared to be an open question whether the original starting point of these ideas, the molecular mechanism of the Bose–Einstein condensation, was essential for the theory.

Quite recently a new possibility has opened for deciding, by experiment, the relevancy of the Bose–Einstein way of counting, without entering into the obscurities of complicated and approximate calculations. Ordinary helium (He^4) has an extremely rare isotope, He^3, which occurs in atmospheric helium, itself a very rare gas, only in a ratio of 1 : 1,200,000. There are very definite reasons, which cannot be explained here, which force the physicist to apply a different way of counting to helium-3 from that used for ordinary helium. According to this particular way of counting, called 'Fermi–Dirac statistics', the helium-3 atoms, at least if they are considered as force-free, would show *no condensation* of the kind derived for 'Bose–Einstein particles'. The manner in which one counts the permutations of 'Fermi–Dirac-particles' does not imply individuality of the molecules either; however, it has a peculiar feature in addition, in that it does not permit several particles of the same kind to have exactly the same velocity. This particular feature of the 'Fermi–Dirac particles' precludes a condensation mechanism of the type encountered for 'Bose–Einstein particles'.

The extreme rarity of helium-3 had prevented experiments with this isotope until recently. Now, appreciable quantities of this isotope can be obtained from the Atomic Energy Commission, since it is one of the many products which can be made by using the strong neutron beams of an atomic pile.

It has recently been possible to liquefy a fraction of a cubic centimetre of pure helium-3 and to measure its vapour pressure curve[8]. The critical temperature and the critical pressure are about 3·34° abs. and 875 mm. mercury respectively.

The experiment in Chicago referred to in the beginning of the present article attacks directly the question of whether or not liquid helium-3 at some temperature in the neighbourhood of 2° abs. becomes superfluid like helium-4. The liquid helium is being pressed through a fine capillary, and one measures the flow velocity at different temperatures. While for liquid helium-4 this flow velocity has, at 2·19° abs., a discontinuity and for lower temperatures suddenly becomes extremely large, the experiments with helium-3 show *no* remarkable change of the flow properties from 3° abs. down to 1·05° abs. The viscosity is of the same order of magnitude as that of liquid helium-4 above 2·19°, and considered as a function of temperature it shows *no discontinuity* in the whole temperature-range measured. This is a negative result, true, still a quite decisive one, since it settles a *qualitative* question. One might hold definite judgment in suspense until the experiment is extended to a still lower temperature. However, the temperature of 1·05° abs. reached so far ought to be quite sufficient to ascertain that the Bose–Einstein condensation mechanism represents the key to the understanding of the unique fluid state represented by helium-4 at temperatures below 2·19°.

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WEATHER AND FARMING IN INDIA

THE world pattern of agriculture is largely determined by the world pattern of climate, and where wide fluctuations from average weather may occur without warning, the results may be catastrophic. Indian fear of flood and drought and of other weather extremes made it imperative that there should be some organised study of weather in relation to crops, and a recently published report* surveys the activities of the Agricultural Meteorology Branch of the India Meteorological Department set up for this purpose in 1932.

The survey is in two sections: the first gives the history of the formation of the Branch, a statement of its objects and a general review of work done up to 1946; the second gives a more detailed accoun of recent activity. One might reasonably expect to find some indication of the impact of the first sixtee years of work on Indian farming; but the mai emphasis is on what was planned, much less o results obtained, and there is none on the applicatio of the results. The report is completed by eleve appendixes, mainly reprints of scientific papers pu lished during the period 1946–48. In the first of the appendixes is a description of the Indian Cro Weather Scheme, and the report notes with natur pride that this scheme was adopted for world use b the International Commission of Agricultural Mete ology at Toronto in 1947. Aiming at the collect of relevant crop and weather data throughout growing year at a network of stations, the sche differs, only in non-essential details from the Brit Crop Weather Scheme started in 1922. As this h been as near a failure as human pride will ever adm it seems a pity that an international conferen should agree to a world-wide experiment witho first being sure that it can be successfully carr out in at least one place. The British Scheme bro down on the biological side, and in this Indian repo there are several hints of difficulties being met in t estimation of "the state of the crop".

An interesting aspect of the work of the Agricultur Meteorological Branch is its attempt to establish weather service for farmers; when the service h been in operation for some years, a critical account its running (including failures as well as success will be of immense value to agricultural meteorolog Seven regional forecast centres have been set up issue detailed weather bulletins and warnings farmers, and the centres are being supplied wi "Crop Weather Calendars" showing the life-hist of the chief crops of the region, their normal weat requirements, and the abnormal weather for wh warnings are necessary at different periods dur growth. This experiment might well be tried e where, and even in Great Britain the regional divis should be regarded as an essential part of the schem

The remainder of the report is largely concern with the work of the observatory at Poona, set in 1933. Again the account is mainly of activ without any attempt at a synoptic survey; there is an impressive list of research problems be investigated in the main branches of agricult meteorology, with an understandable emphasis the physical problems of the heat balance and t water balance of the soil, turbulent diffusion and t n of new instruments. The 1946–48 section more detail than one normally expects in a or's report; but this detail includes some cting tables of night radiation to cloudy and skies, tables of root development and crop h as a function of depth of water-table, and rative readings for different types of evapori- It is to be regretted, however, that physicists waste their time on the Piche and Wild ents.

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* India Meteorological Department. Report on Agricultural Met ology up to 1948. Pp. v+38. (Delhi: Manager of Publications, 1

ing is impossible without water, and much of na research is concerned with the hydrological but there does seem to be a certain lack of icism over fundamentals. An evaporation India, calculated in 1934 from an American al formula, was still in use in 1946 (Appendix ; this shows regions having more than 150 in. ation in a year, one feels that the Indian rs themselves might have asked where the ary latent heat comes from, and to have made assessment of the meaning and reliability of stimate; their failure to do so gives a clue to ource of the chief disappointment felt in reading report. There is little evidence of any integration e many lines of work—all good in themselves— while 207 publications in the period look impres- s a total, there are too many snippets and any repetitions. By decreasing the quantity, a derable increase in quality could be achieved, what is good work would become magnificent. uld be a tragedy, in India as elsewhere, if either oona workers or the Indian Government came to ure the worth of this very valuable research isation by the annual number of publications.

H. L. P.

ARNEGIE TRUST FOR THE NIVERSITIES OF SCOTLAND

HE forty-seventh annual report of the Carnegie Trust for the Universities of Scotland for the 1947–48 refers to the loss sustained by the death e chairman of the Trust, Sir Robert B. Greig, on mber 29, 1947. He has been succeeded by Sir Ireland Falconer.

the field of research, demands for assistance travel and maintenance grants increased, and executive granted £4,000 to supplement university s for assisting professorial and non-professorial in this way. Special grants were made to St. rews for the purchase of four Bell-Gaumont ectors with accessories; to Glasgow for electro- esis apparatus for the Department of Bio- istry; to Aberdeen for maintenance of the mming pool at King's College to permit free use; to Edinburgh for provision of equipment for istic and folk-lore recording in both Gaelic and tish areas. Assistance given to students decreased 7,992 to £43,040, the number of beneficiaries de- sing from 3,068 to 2,368; repayments by former ficiaries also decreased to £2,634, from fifty-four ficiaries.

tails of the eighth quinquennial distribution 7–52) are given in an appendix. They include 350 to the St. Andrews Centre, of which £12,000 housing for university staff, £5,500 for scientific pment, mainly for research, and £6,600 for equip- for the Advanced Medical School and £13,350 niversity College, Dundee, of which £2,350 also is for scientific equipment, mainly for research. Grants to the Glasgow Centre include £70,000 to the University towards erection of the final portion of the Chemistry Institute, £5,500 to the Royal Technical College for the development of a College library service, £2,500 to the West of Scotland Agricultural College and £3,000 to the Scottish Marine Biological Association for renovating the aquarium at Millport Station. Grants to the Aberdeen Centre include £5,000 to the University for library books, £42,000 towards the cost of a new Chemistry Department, £4,000 for equipment for the Mechanical Engineering Department of Robert Gordon's Technical College, £1,000 each to the North of Scotland College of Agriculture and the Macaulay Institute for Soil Research, and £2,000 to the Rowett Research Institute. Grants to the Edinburgh Centre include £23,000 to the University for library expenditure, £20,000 for a lectureship in phonetics and £25,000 for capital expenditure on the Bush and Dryden estates, £5,000 to the Heriot-Watt College for special equipment in the Mechanical Engineering Department, and £2,000 each to the School of Medicine of the Royal Colleges, the Royal (Dick) Veterinary College and the Edinburgh Dental Hospital and School.

The new scheme for the award of fellowships, scholarships and grants for research is again appended, with details of awards made for the year 1948–49, and a list of publications from beneficiaries during 1947–48. In a note on the work of investigators under the research scheme during the year, reference is made to that of Dr. T. S. Hutchison on the strain sensitivity of magnetic susceptibility, of Mr. F. B. Stern on the crystal structure of tartaric acid, of Mr. E. Reid on the diabetonic principle of the anterior pituitary body, and of Miss D. C. Gibb's progress in her investigations on free-growing fucoid algæ. Dr. C. C. Forsyth has continued an intensive study into the place of free diet in the treatment of diabetus mellitus, Mr. J. B. Wilson his investigations of the rates of absorption of different amino-acids of different molecular weight from the intestine of the rat and cat, and Miss R. M. Campbell her study of the effects of various factors on the structure of the liver.

Work in chemistry has chiefly been a consolidation of earlier studies, but special mention is made of Mr. G. W. Youngson's work on polymerization, in which he has built up, on the basis of the pentaerythritol molecule, remarkable 'cruciform' macromolecules in which four big chains of approximately equal length, built up of alternate glycol and adipic acid residues, radiate from a single carbon atom, and more recently, on the dipentaerythritol and trimethylolpropane molecules as bases, six-rayed star-shaped and 'double-Y-shaped' molecules. Mr. C. T. Dickson has continued to work on the structure of colchicine, and Mrs. Storey and Miss B. Cairns on the synthesis of benzacarboline and methoxybenzcarboline and of benzacridone analogues of mepacrine as of possible interest as anti-malarials.

Dr. A. Lamont's work on the rocks in the Pentland Hills assigned to the Silurian system has led to a tentative opinion that the rocks are of earlier date than has generally been accepted. Dr. F. H. Stewart has proved the presence in the complex of basic rocks at Belhelvie, near Aberdeen, of a type of banding, attributed to gravitational settling, that seems to be paralleled in other parts of the world. The Trust has given important aid in the publication of

Dr. A. E. Trueman and Dr. J. Weir's extensive work on British Carboniferous Non-marine Lamellibranchiata. Mrs. E. M. Knox has continued her work on the spores in coal, Miss D. Elrich, at the University of Budapest, has investigated industrial conditions in Hungary, Mr. Gilfillan the social and economic development of Dumbartonshire in the nineteenth century, and Miss A. M. Keay a study of the Forfeited Estates Papers in H.M. Register House, Edinburgh, with the view of elucidating the effect of the policy of the Commissioners on the social and political organisation of the Highlands during the eighteenth century.

The report of the superintendent of the Laboratory of the Royal College of Physicians, Edinburgh, pays a tribute to the work of Lieut.-Colonel W. F. Harvey, who was in charge of the Histopathology Department for twenty years and whose death on September 11, 1948, was a great loss to the Laboratory. Research on the chemotherapy of cancer using transplantable tumours in mice continued, while in biochemistry the discovery of new chemotherapeutic agents was again a chief objective. Some p-phenanthroline compounds proved to have considerable action against avian malaria, and the preparation of chloro derivatives has been completed. Work has also continued on the synthesis of p-phenanthroline compounds containing two basic side-chains, and a number of benzthiazole derivatives, chiefly 6-nitro- and 6-amino-2-styryl derivatives, have been prepared for test for antifilarial activity. The synthesis of benzthiazole compounds has been the chief concern of Dr. J. E. McKail.

CHEMOTHERAPY OF TUBERCULOSIS

THE fourth meeting of the Fine Chemicals Group of the Society of Chemical Industry was held at King's College, London, on January 18, with Sir Jack Drummond in the chair. A discussion on "The Approach to the Chemotherapy of Tuberculosis" was opened by papers by Dr. James Walker and Dr. P. M. D'Arcy Hart, both of the National Institute for Medical Research.

Dr. James Walker said that the limited knowledge of the metabolic processes of the tubercle bacillus has made an empirical approach to chemotherapy inevitable; but research has been aided by the use of wetting agents, such as 'Tween 80', and the addition of serum albumin to liquid media, which make it possible to obtain visible growths from minute inocula of the organism. Compounds at present under trial include the sulphones, which probably exert their action in the body by slow hydrolysis to diamino-diphenylsulphone; the diphenylamine o-carboxylic acids which act as antioxidants in certain biological oxidation mechanisms, and which have shown some inhibitory activity *in vitro*; and the di-alkylsuccinic acids and other substances with lipophilic terminal groups, which may aid penetration of the drugs into the lipoid-rich bacillus. Various antibiotics have been tried against the tubercle bacillus, the best so far being streptomycin.

Dr. D'Arcy Hart said that sulphetrone and its analogue promizole, the least toxic of the sulphones, have produced some regression in the acute forms of human infection, and calciferol has brought about dramatic and consistent improvements in lupus vulgaris. Streptomycin has proved life-savin proportion of cases of tuberculous meningit miliary tuberculosis, hitherto invariably fatal, is useful in less serious forms of the disea clinical use is limited by its toxicity and by th resistance which develops in some patients treatment. Lastly, p-aminosalicylic acid h promise and is under trial in Great Brita alone and in conjunction with streptomycin

Much yet remains to be done; but chemothe already given a new edge to the sword of e practice, and the time may not be far tuberculosis will cease to be the greatest d useful lives in Western civilization.

CORRELATION OF EVOLUT OF HOST AND ECTOPARAS

UNDER the title "Some Rules in Ectoparas Dr. W. Eichler, of Ascherleben, German tributes an interesting paper to *The Anna Magazine of Natural History*, Series 12, No. 8 (1948). It has long been known that the classification of some groups of animals of habits corresponds with that of their hosts Fahrenholz was one of the chief protagonists rule (in regard to the Anoplura in particula author has named this general principle "F holz's Rule". It applies, for example, to groups of ectoparasites and their hosts. Fahr argued that the ancestors of extant parasites have been parasites of their original ancestral evolution of host and parasite consequently gone on side by side. The conclusions drawn the classification and relationships of many gro parasites enable light to be thrown on the n relationships of their hosts—even in cases whe latter show very divergent features from members of their group.

One of the best examples of the working principle is in the case of the flamingo—a bird is placed by some ornithologists among the whereas others relegate it to the storks. Thos think it to be a duck explain its long stork-li as convergence owing to similarity of habit. maintain that it is, in fact, merely an aberrant whose duck-like bill is the result of convergence evidence afforded by the parasites of flam strongly argues in favour of their derivation those of ducks. Thus the bird lice show in the a clear affinity with those living on the An The ostrich and rheas are only parasitized b lice and feather mites common to those birds. evidence is also confirmed by the cestode nematode parasites of those two groups of bird

Szidat (1939) has shown in his studies of th cycles of Trematoda that primitive hosts are sitized by primitive types of tremades and speci hosts by specialized parasites. He quotes the par of various vertebrates in support of his conte In the trematode subfamily Asymphylordorina hosts are fishes of the family Cyprinidæ, which their developmental centre in East Asia. In region some of these Trematoda occur among dif genera of Cyprinidæ, but with the spread o fishes to Europe the parasites become more spe a with the result that they become restricted particular Cyprinid genus or, in one case, to a species.

Eichler also explains what he calls the gence rule". Where there are groups of hosts many species, he deduces the rule that the more host is infested by different genera of parasites er must be the group to which that host This principle is illustrated by many of the aga that infest large groups of closely related The fact that the tinamon Mallophaga are nerous in genera is exceptional for the para- bird group containing so few species. It perhaps, that the Tinamidæ was a much oup of birds at one time, most of its species lied out.

ESEARCH IN INDUSTRIAL RELATIONS

the 1948 mid-winter meeting of the American Philosophical Society, which was held at Phila- ia in February 1948, papers were read dealing research frontiers in human relations.

of these papers, by Prof. E. Wight Bakke, of niversity, dealt with the subject of research ndustrial relations and suggested that the in recent years by leaders of management and r for basic principles of human relations on they might build new techniques in their own or- ations has been in vain (*Proc. Amer. Phil. Soc.*, 92, ; Nov. 12, 1948). According to Prof. Bakke the ologists have come closest to providing the cal men with the most useful principles, and of them have contributed by the development of for prospective employees, attitude surveys, niques for building morale, training of supervisors, similar projects. Other psychologists have also rtaken a careful analysis of the motives for and minants of behaviour among workers themselves. ropologists, sociologists and economists, too, carried out investigations; but these have only loosely connected with the subject of trial relations, and no common theory running gh this research into human relations has ged.

is not surprising, therefore, that the leaders of gement and labour have been unable to turn to a ndable and useful science of human relations. ner is it surprising that the men of action have been able to find what the men of science have unable to find or produce, namely, an integrated of principles of human behaviour on which the niques for the organisation and direction of an beings in purposeful group activity' could ested and on the basis of which effective action d be developed.

an attempt to determine the particular type of arch into industrial relations in which the elopment of a scientific theory of human inter- ion and of the determinants of human behaviour ld be the dominating consideration, Prof. Bakke ts that industrial relations are simply one kind of an relations. The principles which govern men's ns and relations in industry are no different lly from those which govern their social, their s, their familial, their educational, and their ical activity and relations. The distinguishing ks of this kind of industrial relations research ld be :

1) The general problem must be defined as one earning the determinants of human action.

(2) Specific questions must be shaped by reference to the need for amplifying or modifying a basic theory of cause and effect.

(3) Group-wide or group-wise behaviour and the group as an organic entity must be emphasized.

(4) A diagnostic pattern outlining all personal and environmental facts needed for adequate explanations must be utilized.

(5) Attention must be paid to the definition and measurement of data in quantitative terms.

(6) Field observations must be used as the major source of data.

(7) Theory must be progressively formulated and tested in the laboratories of industrial and union operations.

This kind of research may be described as a 'frontier' activity primarily because it is seeking to develop systematic principles of cause and effect in a field of behaviour in which such principles are not understood. Here the most pressing need of to-day is for studies not only of personnel policies but also the nature of persons; not only of incentive systems but also of human incentives; not only of collective bargaining procedures but also of the factors which mould the actions and attitudes of the bargainers; not only of bargaining issues but also of the structures of living of the parties which give them varying and conflicting 'slants' on the issues; not only of the structure of management and unions, but also of the compulsions these structures impose upon the actions and thoughts of the men who represent them; not only of techniques for organising enterprises or unions, but also of the principles of effective association and group solidarity and teamwork.

This type of research raises many problems, in addition to the scientific problems of the research itself. It is expensive. The facts must be gathered through field-work of a comprehensive nature. The personnel who can collect the facts must have a breadth of training and knowledge preferably in more than one discipline. A further difficulty arises out of the necessity for a partnership of the men of science with the men of action, management and trade unionists, in the collecting of facts and the testing of conclusions. Even when co-operation is obtained, there is the necessity for accurate and full reporting of results which are not always easy to reconcile with the requirement for avoiding harm, actual or feared, to the co-operating organisations and individuals. There is also the necessity for using a language in describing scientific results which is understandable to men who are not trained in science.

In conclusion, Prof. Bakke describes the value of theory in the advancement of knowledge and its application to the solution of the world's industrial problems. The increase in quantity and quality of material goods which flow from industrial operations is as dependent on the effective co-ordination of people and efficient team-work as upon the adequacy of tools and technique. The processes of democratic society are seriously disturbed by industrial warfare. The practical decisions in ordering human relations so that the public interest may be met depend on the leaders of industry and unions. Changes in technology, in economic, social and political situations, are constantly inserting elements, of which the old techniques took no account, into the problem. To-day, more than formerly, he is poorly equipped for adaptive action, in industry or elsewhere, who knows merely what to do but not why he does it.

T. H. HAWKINS

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 2

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"As Seen by Denmark" (Sound films with introduction by Dr. Ingolf Boisen).

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Bernard Payne: "Air Lift Pumping".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. J. Cole, F.R.S.: "Aspects of Biological Discovery, 1, Spontaneous Generation".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Capt. H. Topley: "Navigation at Sea" (Science and Marine Navigation, 4).

Society of Chemical Industry, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Annual General Meeting; Mr. M. P. Balfe: "Leather—the Scientific Background to a Traditional Industry".

Tuesday, May 3

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Annual General Meeting; Dr. L. E. Rya[illegible]: "The Scientific Work of the Post Office".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. M. Grace Eggleton: "Physiological Properties of Ethyl Alcohol".* (Further Lectures on May 10 and May 17.)

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. G. W. O. Howe: "Some Electromagnetic Problems".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. J. McConnell: "Function Space and Applied Mathematics".* (Further Lectures on May 4 and May 6.)

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Scientific Approach to Human Problems in Industry" (to be opened by Sir Frederick Bartlett, F.R.S., Mr. Alec Rodger and Dr. Elliott Jacques).

Wednesday, May 4

Royal Society of Medicine, History of Medicine Section (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Annual General Meeting; Dr. E. Ashworth Underwood: "To Edward Jenner on his 200th Birthday" (Presidential Address).

Society of Public Analysts and other Analytical Chemists (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, May 5

University of London (at Wye College, Ashford, Kent), at 5.15 p.m.—Prof. G. E. Blackman: "Modern Methods of Weed Control".*

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. E. Rowland: "Some Aspects of Agricultural and Horticultural Electrification in the United States".

Royal Meteorological Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Mr. E. Gold, F.R.S.: "Meteorology in the First World War".*

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Mr. W. G. Roberts: "Ceramic Capacitors".

Friday, May 6

Physical Society (at the Royal Institution, Albemarle Street, London, W.1), at 4.30 p.m.—Annual General Meeting; at 5 p.m.—Prof. G. I. Finch, F.R.S.: Presidential Address.

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. P. E. Kent: "A Structure Contour Map of the Pre-Permian Rocks of England and Wales".

Friday, May 6—Saturday, May 7

British Rheologists' Club (joint meeting with the Local Section of the Chemical Society, at the Washington Singer Laboratories, University College, Exeter), at 9.45 a.m.—Discussion on "Suspensions and Sedimentation".

Saturday, May 7

Biochemical Society (in the Department of Biochemistry, University Museum, Oxford), at 1 p.m.—Scientific Papers.

Linnean Society of London (at the Herbarium, Royal Botanic Gardens, Kew), at 2.30 p.m.—Demonstration: "Botanical Taxonomy after Linnaeus".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Science Officer, Directorate, Shanghai—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (May 7).

Senior Lecturer or Lecturer in Cytology, and a Senior Lecturer or Lecturer in Genetics—The Registrar, The University, Manchester 13 (May 7).

Mechanical and Aeronautical Engineers (unestablished Senior Scientific Officer grade) with experience in airframe stressing and design calculations or in the design and development of small mechanical components, at Royal Aircraft Establishment, Farnborough and other Ministry of Supply Establishments in South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.882/48A (May 7).

Senior Lecturer in Mechanical Engineering—The Principal Royal Aircraft Establishment Technical College, Farnborough, Hant. (May 7).

Lecturer in Philosophy—The Registrar, King's College, Newcastle-upon-Tyne (May 7).

Physical Chemists as Scientific Officers at a Ministry of Supply Research and Development Establishment near London, for duties in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography, and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A (May 10).

Wellcome Research Fellowship in veterinary science or practice—Dr. W. R. Wooldridge, Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1 (May 14).

Lecturers (2) in Fuel Technology, an Assistant Lecturer in Physics, and an Assistant Lecturer in Geography—The Registrar, The University, Sheffield (May 14).

Lecturer or Assistant Lecturer in Genetics, a Lecturer in Botany (preferably with Morphology or Ecology as a special interest), an Assistant Lecturer in Plant Physiology, and an Assistant Lecturer in Geography—The Secretary of University Court, The University, Glasgow (May 14).

Leverhulme Studentships in Chemical Engineering—The Secretary, University College, Gower Street, London, W.C.1 (May 15).

Fellowship and Scholarship for session 1949–1950—The Secretary, British Institute of Archæology at Ankara, 56 Queen Anne Street, London, W.1 (May 16).

Lecturer and an Assistant Lecturer in the Department of Zoology, a Lecturer in Industrial Hygiene and a Research Assistant in Social Medicine in the Department of Social and Industrial Medicine—The Registrar, The University, Sheffield (May 21).

Chief of Division of Electrotechnology, National Standards Laboratory, Sydney (Ref. No. 2208), a Senior Research Officer on the Editorial Staff of the Council for Scientific and Industrial Research, Melbourne (Ref. No. 2188), and a Research Officer, Division of Plant Industry, Hobart (Ref. No. 2068)—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 21).

Senior Lecturer in Psychology (General Psychology with special emphasis on Educational Psychology) in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 30).

Senior Lecturer in the Department of Electrical Engineering in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 31).

Assistant Lecturers or Lecturers in Pure Mathematics, Applied Mathematics, Civil Engineering, Mechanical Engineering, Agricultural Organization and Economics, and Agricultural Chemistry, at the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (June 1).

Lecturer in Physics (in Pietermaritzburg), a Lecturer in Experimental Physics (in Durban), and a Lecturer in Botany (in Pietermaritzburg), in the University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 15).

Senior Research Officer-Chemist, and a Research Officer-Chemist, in the Paint Industries' Research Institute of the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

Technician for the Physiology Department—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Lecturer in Dairying, and Assistant Lecturers in Agricultural Chemistry and Genetics, at the School of Agriculture, Sutton Bonington, Loughborough—The Registrar, The University, Nottingham.

Graduate (preferably with research experience in biochemistry or chemistry) to assist in investigations on intermediary metabolism—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.

Lecturer in Botany (with special reference to plant metabolism), Assistant Lecturers in Geography (with special qualifications in Political Geography) and Mathematics, and Demonstrators in Botany (*a*) with one year's experience of research in mycology, (*b*) with one year's experience of research in bacteriology—The Registrar, The University, Nottingham.

Cerealist by the Government of Iraq for the Directorate-General of Agriculture—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18187.3F.

Assistant Professor of Anatomy—The Dean of Medicine, University of Alberta, Edmonton, Alberta, Canada.

Laboratory Steward—Prof. I. Manton, Department of Botany, The University, Leeds 2.

Physical Chemist or Metallurgist for work in connexion with both laboratory and practical studies of various aspects of iron-making processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Iron Making'.

Lecturer in Chemistry—The Principal, Royal Technical College, Salford 5.

Director of the West African Building Research Organization—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Head of the Department of Flight—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

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WESTERN CIVILIZATION AND FREEDOM OF THOUGHT

"THE scientific outlook and scientific power increasingly dominate our age," writes Mr. John Bowles in his recent book "The Unity of European History"; and, in words strongly reminiscent of those used by H. A. L. Fisher in "A History of Europe", Mr. Bowles continues: "but unless traditional humanist values can be adapted and preserved, the progress of science will be empty and catastrophic. The study of the European past demonstrates the unity of Western culture, the values of the Christian and the Humanist tradition and the pernicious limitations of nationalism and class war. In the light of such knowledge, science can build a society which combines the power of modern technique with the spiritual depth of old experience." Mr. Bowles's political and cultural survey is written largely around a sentence of Mr. Winston Churchill's speech at The Hague Congress of Europe on May 7, 1948, as text: "We shall only save ourselves from the perils which draw near by forgetting the hatreds of the past, by letting national rancours and revenges die, by progressively effacing frontiers and barriers which aggravate and congeal our divisions, and by rejoicing together in that glorious treasure of literature, of romance, of ethics, of thought, and of toleration belonging to all, which is the true inheritance of Europe". To the scientific element in that inheritance Mr. Bowles possibly does less than justice, particularly to its cultural and political significance. Nevertheless, his book displays the vitality as well as the success of European civilization, and he shows clearly how much we have to learn from past ages as to the real nature of the dangers that threaten us to-day.

Like the Russian historian, Restovtzeff, Mr. Bowles sees in the failure of the upper class in the Roman world to extend their culture to the rural and the urban proletariat the fundamental cause of the decline of ancient civilization; and he observes that civilization is dependent on an individual creative genius, on the maintenance of a favourable environment for its realization and upon the preservation of intellectual standards. "No more than Græco-Roman society can modern society continue stable unless the masses participate in the minority culture without lowering its quality. It is the cardinal task of modern civilisation to preserve such standards, to democratise culture without debasing it, to transmit a modernised version of traditional values to the masses and to create a public opinion which respects knowledge."

The recurring theme throughout the book is that freedom of thought and the Christian respect for the individual are the very roots of European civilization, and Mr. Bowles shows from what diverse sources the tradition is derived. He quotes Spinoza that "the ultimate aim of government is not to rule by fear . . . but to free men from fear . . . to enable men to develop their minds and bodies in security and to employ their reason unshackled"—words which are strangely pregnant again to-day; and on the other hand, he shows the evil that flowed from Hegel's attack on individual rights and impartial law. He brings out, too, the way in which the increase in population, the intricate world-wide structure of modern industry, the revolution in transport and so on have made imperative a planned international and economic order.

Even where Mr. Bowles simplifies too much, he rarely fails to show that the outstanding characteristics of Europe have been freedom and initiative, reflecting a fortunate environment, and that from this enterprise have flowed a brilliant and diverse culture and unprecedented scientific power, the immense advantage of which Western Europe has enjoyed over the rest of the world through its long lead in scientific and industrial techniques. He does not rest content with stressing the dependence of the democratic way of life for its continuance on a co-ordinated drive to ensure self-government and the rule of law in national and international affairs which will guarantee freedom from fear; with the planning of economic life to ensure freedom from want; with the maintenance of freedom of worship, thought and speech. He also points to definite responsibilities in this field on the part of professional organisations.

The vitality needed to deal with contemporary dangers, Mr. Bowles reminds us, can only be maintained by preserving the widest freedom of thought. Such freedom has been the secret of all the great creative epochs, as of modern science itself, and with it now must go the maintenance of independent professional organisations, strong enough to influence public opinion and the policy of the State, and uniting professionally competent experts in a common front. If this freedom and unity can exist, a creative civilization can continue: the alternative is totalitarianism.

Mr. Bowles thus regards professional organisations as possessing the same vital functions for civilization that were visualized by Sir A. M. Carr-Saunders and P. A. Wilson in their study of the professions published some sixteen years ago. They saw vocational associations, with the emphasis shifted from mere organisation to vocation or service, as providing professional men with permanent anchorage and shelter, from which secure positions they could set out to shape organisations into instruments for the fulfilment of their purposes. Carr-Saunders and Wilson had then sensed something of the oppression which the rising totalitarian systems were to exert, and of the need for democracy to brush away inefficiency and organise a free society for the good life. The years between have emphasized the continuing reality of that threat, and the dependence of progress upon a minority of creative minds functioning in an environment of freedom of thought and utterance.

To maintain intellectual standards and the intellectual freedom in which alone they can be preserved is a first responsibility of all professional associations. Some such bodies have always had special responsibilities in this matter, and have rarely for long been unmindful of them. Dr. A. Mansbridge noted, for example, in "The Kingdom of the Mind", that all the old universities of Europe represent historically the development of communities for common interest and protection in the pursuit of learning; and, abov all things, their story is the story of European unit and citizenship. Recognition that the universiti and professional institutions have a part to play i the defence not merely of freedom of expression bu even of freedom of thought itself, should not lead u to overlook their continuing contribution to Europea and indeed world unity. Moreover, the conditions i which alone science and scholarship can flourish, o even exist, are those where respect for truth an respect for persons are inherent in the general soci tradition.

The essential basis of unity for Western Europ is not a political creed but a belief in all the principle linked with an indispensable principle of liberty, an the defence of that liberty is not primarily a politica issue but a responsibility resting on all such institutions as universities and professional associations a well as religious bodies. Moreover, as Prof. R. B Goldschmidt recently emphasized, it is only in th last two decades that there has been any seriou interference with the freedom of science by Governments. There have always been organised groups o different types who clamoured for such interference but in the nineteenth century even the wors reactionaries did not go so far as to abolish th freedom of teaching. Incidentally, Prof. Goldschmid takes the same view as Sir Robert Robinson, in hi presidential address last year to the Royal Society that in Great Britain the immediate danger to th freedom of science is less of direct attack than o relative depreciation of fundamental research in comparison with technological applications. The body scientific can only flourish when all its organs are i a healthy condition, and where there is a socia tradition which respects truth, even abstract truth for its own sake.

The most important chapter in Prof. G. S. Ghurye' recent book, "Culture and Society"*, is that in which he deals with this question, and more generally with the part the universities have to play in creating an maintaining civilization and culture at a high level Just how high cultural values are to be created an maintained, or how the passive practitioners o culture are to turn civilization into culture, he does not indicate; but very clearly he regards it a primarily a task to which the universities mus contribute the inspiration. He recognizes that ther are potentialities in planning which tend to work against individual development and realization; an that a planning society, if it cares for civilization an culture, must strengthen its universities. He remind us that it is the business of social organisation t provide conditions wherein individuals can realiz themselves to the fullest; while the strengthening o the universities involves both full autonomy in th body politic and redressing the balance of studies, nov tilted heavily in favour of science and technology, s that the humanistic studies are adequately developed

Here Prof. Ghurye is positive and emphatic, an although his otherwise somewhat discursive surve of nineteenth- and twentieth-century thought gives no clear answer to the questions: "What is culture?", and "What is civilization?", he may well have helped his readers to find their own answers. His book should correct some shallow thinking. Like Mr. T. S. Eliot, he recognizes that the whole of European culture is largely the product of Christianity. Like Mr. Eliot, too, he urges the maintenance of standards and the return to the study of those subjects by which the essentials of culture are transmitted; but he shows something which Mr. Eliot does not, namely, the seed of faith in our humanity. Prof. Ghurye has not entirely lost that faith in the power of man to preserve the best of his old culture while creating from his own spirit a new culture. He demonstrates anew the relevance of much of the thought of Whitehead, Russell and others to this problem of the nurture of a free culture in which creative thought is possible, and the vital necessity of free institutions under a democratic regime. Though he touches only the fringe of the political field, the implication is plain: that the universities, professional associations and the learned societies must take thought and care that the life of the society in which they are placed is not so ordered as to preclude the essential conditions for their work.

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* Culture and Society. By Prof. G. S. Ghurye. (University o Bombay Publications, Sociology Series No. 1.) Pp. x+237. (Bomba and London: Oxford University Press, 1947.) 30s. net.

An immense responsibility thus rests on the universities and the professional bodies, including the learned societies; but it carries no implication that scientific men and other scholars are inherently qualified to be the saviours of society. They must, indeed, meet the fresh threat, wherever it comes from, to their right to declare and sustain by argument what they believe to be true, a right which has long been the condition of the whole intellectual life of Western Europe. On the right to make and test hypotheses through observation and experiment, to proclaim freely and discuss the conclusions to which inquiry leads, there can be no compromise. When that way is imperilled, scientific workers are bound to join, with fellow men of learning and of every walk of life, to safeguard the continuance of those free institutions through which the great heritage of Western culture has flowed, or they repudiate the very spirit and method of science.

OSCILLATING STARS

The Pulsation Theory of Variable Stars

By Svein Rosseland. (International Series of Monographs on Physics.) Pp. viii+152. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 18*s*. net.

CEPHEID variable stars—the name given to stars which behave like δ Cephei—have played a distinguished part in modern astronomy. Their most characteristic feature—that there is a definite relation between period and median absolute luminosity—was discovered by Miss Leavitt in 1912 when investigating the Lesser Magellanic Cloud. Owing to this relation, the measurement of period and apparent magnitude allows one to compare the absolute and apparent luminosities, and so affords a reliable estimate of distance, once the zero point of the period-luminosity curve has been fixed. In this way, Shapley determined the distances of the globular clusters, and Hubble determined the distances of the extra-galactic nebulæ.

This would be sufficient glory for any ordinary type of star, but Cepheids have other claims to distinction. Originally supposed to be close binaries in virtue of the periodic shifts in their spectral lines, they were identified by Shapley in 1914 as stars in a state of pulsation, and it was Eddington's attempt in 1917 to give Shapley's hypothesis a precise mathematical form that led Eddington to investigate the equilibrium of non-pulsating stars as a norm, and so to put forward his celebrated theory of the radiative equilibrium of the stars. In another direction, the slow secular decrease in the periods of Cepheids led Eddington to an estimate of the rate of stellar evolution. Since then, their intriguing features have led a host of observers to make refined observations of their light-curves and velocity-curves, and a host of mathematicians to elaborate the pulsation hypothesis.

For several years now, Prof. S. Rosseland, of Oslo, and his co-workers have been engaged in studies of solar and stellar hydrodynamics, and the present admirable volume from his pen gives a detailed account of the application of hydrodynamics to the case of stellar pulsations. It contains not only the classical pioneer investigations of Eddington, but also the less well-known recent researches of the American and Dutch schools, together with many hitherto unpublished results of Rosseland himself. The whole book is written in a most attractive style. Rosseland uses his earlier experience in the analytical dynamics of the quantum theory to put the theory of radial pulsations of spheres of gas into canonical, Hamiltonian form, and exhibits it as a branch of the grand theory of oscillations of dynamical and thermodynamical systems. The issues are thus presented in a form which will appeal by its generality to a large class of readers over and above those professionally interested in variable stars.

Almost every theoretical astrophysicist has had a shot—many of them substantially more than a shot—at solving the outstanding problems which Cepheids offer on the pulsation hypothesis, such as the skewness of the velocity- and light-curves, and the coincidence of maximum luminosity with maximum velocity of approach of the stellar surface. The full bibliographical references given by Rosseland make the reader realize how great a loss the subject suffered through the early death of Woltjer, the Dutch astronomer; and what important contributions have been made recently by Martin Schwarzschild, son of one of the fathers of astrophysics, by Ledoux, the Belgian worker, by Miss Kluyver and Wesselink in Holland, by Biermann in Germany, and by Cowling in Great Britain.

What is the present position of the pulsation hypothesis? Rosseland chooses the wise course of not advocating any particular form of the hypothesis; but attempts to bring out the real difficulties involved and to develop general methods of attack capable of application whatever new observational features the future may have in store. To me it seems that the well-tried methods fail on the whole to account for the phase-relation in Cepheids. It seems incredible that the various causes of phase-lag treated by Rosseland and others should accumulate up to exactly a quarter-period, or that combinations of higher harmonics, or anharmonics, should yield simultaneously the observed asymmetry of the light-curve and the clear but unexpected phase-relation of the light-curve to the velocity-curve.

Rosseland nowhere mentions what appears to me to be the most striking feature of the observed oscillation, *qua* oscillation, namely, that in the course of the complete oscillation the star never passes through its associated equilibrium configuration—it cycles around it. This is utterly unlike the behaviour of oscillating systems in mechanics. Rosseland gives short shrift to my attempt to *begin* with the energetics of the oscillation, urging that since the solutions have not been derived so as to satisfy the hydrodynamical equations of motion, they need not represent mechanically possible motions. But 'mechanical' solutions have, on the whole, failed to represent the phenomenon. It might equally be urged against the mechanical solutions that the adiabatic hypothesis on which they are based is, as applied to a star, self-contradictory; for if the star is imagined to consist of adiabatically-walled cells of material, the normal flow of energy through the star, which maintains the luminosity, would also be inhibited. The solution in terms of energetics gives at once the asymmetry of the light-curve.

However that may be, Prof. Rosseland is to be congratulated on having produced an entrancing study of an entrancing subject, and on having opened far-stretching vistas in the mechanics and thermodynamics of oscillation theory. It may be added that the book is not confined to Cepheid variables, but treats also of long-period variables, cluster-type variables, variables of special types and novæ.

E. A. Milne

SCIENCE IN CHINA

Science Outpost

Papers of the Sino-British Science Co-operation Office (British Council Scientific Office in China), 1942–1946. Edited by Joseph Needham and Dorothy Needham. Pp. 313+24 plates. (London: Pilot Press, Ltd., 1948.) 25*s.* net.

THE core of this book consists of a series of articles on science in China which originally appeared in *Nature* during 1943–46. With them are reports on the first three years working of the Sino-British Science Co-operation Bureau (February 1943–February 1946), a broadcast from London called "Science and Life in Wartime China" (December 1944), Dr. J. Needham's original memorandum from Chungking on an International Science Co-operation Service (July 1944), and a reprinted paper on the Chinese contribution to scientific humanism. The original part of the book comprises the excerpts from letters, extracts from the logs of the north-west journey in 1943, of a journey on the Burma road in September 1944, of the south-east journey in April 1944 and of a journey in Shensi in October 1945, entries from the diary of Mrs. Needham, and a number of poems by Rewi-Alley, with two by Dr. Needham himself.

To this vivid material, in which the warm human sympathies of the Needhams are so clearly if unobtrusively displayed, the book owes its charm. Of the poems, no more need here be said than that Dr. Needham's "Poem for a Chinese Friend" and the translation of "The Ballad of Meng Chiang appear to convey the Chinese atmosphere most clearly. For the rest, the poems are less successful than the extracts in displaying the conditions under which the staff of the Sino-British Science Co-operation Office worked during these years, and the background against which the scientific workers and technologists of China sought to maintain and develop the ancient civilization of their country. An excellent series of illustrations contributes to the same end, while the list, which is appended, of 139 papers by Chinese men of science transmitted by the Office for publication in the West, shows that the flow of knowledge through the Office was from East to West as well as West to East.

As a travel book it should appeal to both the scientifically trained and the layman. Dr. and Mrs. Needham have compiled it to do justice to the achievements of the scientific workers and engineers of China. The book may have some further interest as giving, in a modest way, some indication of what is at stake in the present struggle in China, at least so far as science and technology are concerned. But it may, perhaps, take a more permanent place in the literature of science as a simple record of the human values of pertinacity, courage and sympathy on which the achievements of the Sino-British Science Co-operation Office are firmly based and which are demanded as the price of service no less in the field of science than in other fields of human endeavour.

R. Brightman

SCIENCE FOR THE LAYMAN

Into the Atomic Age

By Chapman Pincher. Pp. 158 + 36 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1948.) 9*s.* 6*d.* net.

A Study of Fishes

By Chapman Pincher. Pp. 304. (London: Herbert Jenkins, Ltd., 1948.) 15*s.* net.

A LITERARY problem which does not become less difficult with the increasing complexity of science is that of presenting recent discoveries in a form which is intelligible to the layman. Usually, when an author announces that he is writing a popular book on a scientific topic for the layman, it means that he is either writing a non-specialist book which will be of general interest to the specialist in some other subject, or he is writing a book which will capture the fancy of the general reading public because of the intrinsic interest of the subject itself.

It is to these two groups that Mr. Chapman Pincher appeals with his "Into the Atomic Age". As scientific correspondent to the *Daily Express* he has learned that the majority of his readers are more interested in bits of information about scientists and their lives than about science itself and, in his book, he has carefully blended some straight reporting on the theoretical, technical and military aspects of atomic energy with accounts of meetings he has had with leading atomic scientists in the course of his work. The lay reader is thus carefully led along the road where developments in atomic energy have been made by stages where stiff climbs on technical matters alternate with rests in which information about great men and their careers can be given. The whole book suggests that Mr. Pincher has not only studied his subject and the art of putting it over, but also the public whom he is trying to reach.

There is also a third group of the reading public for whom the scientific author tries to cater. This is the laity with strong interests in a particular hobby or craft and who are always keen to extend their knowledge of the hobby or craft. In "A Study of Fishes", Mr. Pincher sets out to provide scientific information for the angler which will add to his understanding and, by replacing some of the theories which rely more upon imagination than objectivity, improve his technique on the bank or shore. The book is thorough and contains much that will help the fisherman to understand practical points which he has picked up by experience and hearsay. It is doubtful if the author is wholly successful, however, for whereas topics like the bending of light, the dyeing of maggots, and streamlining should present no great difficulty, sections on breeding and pigments with strange words like genes and chromosomes and peculiar chemical formulæ of substances like melanin might prove to be very disconcerting. The frequent use of American names like killifish and squeteague is equally disturbing, and, although the name and usual location of strange fish can be found in a well-prepared list at the back of the book, the general reader is usually not adept at making frequent references to another part of the book. For him this is meant to be a work to read and not an encyclopædia. If these defects are eliminated in subsequent editions, there is little doubt that "A Study of Fishes" will become a book read and valued by many anglers.

T. H. HAWKINS

DEMOCRITUS OF ABDERA

Le dottrine di Democrito d'Abdera

By Federigo Enriques e Manlio Mazziotti. Pp. xxii+339. (Bologna: Nicola Zanichelli, 1948.) 1,500 lire.

FEDERIGO ENRIQUES, whose death at the age of seventy-one occurred in 1946, was one of the leading Italian mathematicians of our time; he is specially renowned for his joint creation, with Castelnuovo, of the invariantive theory of algebraic surfaces, which will remain one of the glories of Italian mathematics. As an example of versatility, moreover, Enriques was outstanding; for, over and above his purely technical achievement, which suffices to place him in the front rank, he maintained a lifelong interest in the history and problems of science which, in the "Encyklopädie", his books and articles on one hand, and in his lectures at Bologna and Rome on the other, earned him a second reputation. Above all, he was attracted to speculation concerning the Greek contribution to science, partly, no doubt, because the fragmentary nature of the evidence leads to fascinating conjecture.

At his death Enriques left two completed manuscripts, one (in course of publication) on the theory of surfaces, and the other on the atomist Democritus of Abdera (*c.* 500 B.C.). Knowing the man, one can readily appreciate the appeal of this theme—the reconstruction and interpretation, from stray sentences and commentators' allusions, of the thought of a philosopher whom Enriques esteemed among the greatest of the Greeks. The difficulty of the task is increased by the fact that no one can be sure how much of the fragments remaining to us is due to Democritus and how much to his master, Leucippus.

Like much of Enriques's work, the book is a collaboration, in which the arrangement and interpretation of the text is due to Dr. Mazziotti, the superstructure being largely Enriques's own. Each chapter deals with a particular aspect of Democritus's contribution to philosophy; it opens with a detailed and acute critique of the subject-matter from the modern scientific point of view, after which come the various classical texts (in Italian translation), accompanied, wherever necessary, by brief comment or explanation. All this material is arranged in thirteen chapters, which cover the whole field of Greek thought, from natural science and geometry to biology, logic and ethics. The masterly comments can be read and enjoyed for their own sake, irrespective of their bearing on the historical and technical problems which the author seeks to elucidate; and the book should, therefore, reach a wide circle of readers.

L. ROTH

VETERINARY PROTOZOOLOGY

Veterinary Protozoology

By Prof. Banner Bill Morgan and Prof. Philip A. Hawkins. Pp. vii+195. (Minneapolis, Minn.: Burgess Publishing Co., 1948.) 4 dollars.

THIS book has been written for veterinary students, practising veterinarians and agricultural students, and its scope is similar to that of U. F. Richardson's book reviewed recently in these columns (*Nature*, 162, 756; 1948). It is a useful book, full of practical information; but the size of its page (11 in. × 8½ in.) makes it rather inconvenient to handle, and its small type, clear though it is, is not read with comfort on a page of this size. Its illustrations, with the exception of the frontispiece, are all in line and stipple, and are all unusually large. Many of them are so much simplified that they lose much of their value. One cannot help thinking that a reduction of their size would have made a smaller page possible and would have released space for more of the useful text.

One doubts, for example, whether any reader will require a *Tritrichomonas* four inches in overall length; or coccidian oocysts on a similar scale, which do not show the spores and residual bodies which are essential if the figures of the oocysts are to be aids to diagnosis of the species. Photographs of oocysts are used in other books, and they give a much better idea of what is actually seen through the microscope. The frontispiece, a microphotograph of *Tritrichomonas fœtus* magnified until it reaches an illustrated length of 7½ inches, cannot be called a satisfactory representation of this species, and the diagrams of it printed elsewhere in the book are more useful.

The text of the book contains a great deal of valuable information. It begins with a brief general account of the Protozoa, which might have been more carefully worded. Of the Sporozoa, for example, the authors say that "Reproduction is by schizogony (spore formation)", a phrase which fails to distinguish between the asexual process of schizogony and the formation of spores after a sexual process. A similar failure to supply the biological basis of the veterinary specialist's work is evident in the statement that

"Reproduction" of the Ciliata "is mainly by conjugation; asexual reproduction by binary fission occurs"; and in the definition of the reservoir host as "a host harboring parasites which may be transferred from man to domestic animals", a statement which is inadequate even in the restricted field of veterinary protozoology.

Criticisms of this kind do not, however, apply to the greater part of the book, which gives a detailed and valuable account of the Protozoa that cause diseases of farm stock, and of the symptoms, diagnosis and treatment of these diseases. The hosts considered in turn are horses, cattle, sheep and goats, swine, dogs, cats and the 'fur-bearers', namely, the fox, rabbit and mink. *Tritrichomonas fœtus* and the disease it causes receive considerable attention, and there is, at the end of the book, a diagram of a plan for hygienic breeding designed to eradicate bovine trichomoniasis and also, in the useful section of the book on diagnosis of protozoal infections, a large plate of diagrams of Protozoa likely to be encountered when trichomoniasis is being diagnosed. Another plate illustrates the not very complex instruments used by the authors for diagnostic work. Some of the space given to these plates might well have been given to structures, such as seeds and fragments of various kinds of foods, which may resemble coccidian oocysts and dying or degenerate Protozoa in the fæces. Even a reduction in size of the figures would have made this possible.

Workers who have difficulty in obtaining the literature of this subject will find a good summary of it in this book, and also a bibliography, extending to 18 pages, which includes important books, a list of the circulars and bulletins on protozoal diseases issued by the United States Bureau of Animal Industry and Department of Agriculture respectively, as well as references to 309 research papers. There are also useful host-parasite lists, schedules of treatment and a brief article on the International Rules of Zoological Nomenclature.

G. LAPAGE

NON-LINEAR WAVE MOTION

Supersonic Flow and Shock Waves

By R. Courant and K. O. Friedrichs. (Pure and Applied Mathematics, a Series of Texts and Monographs, Vol. 1.) Pp. xvi+464. (New York and London: Interscience Publishers, Inc., 1948.) 42*s*.

TWENTY-FIVE years ago what was known on the dynamics of gases, if acoustics and the study of steady motion at speeds small compared with that of sound (when the flow resembles that of a liquid) be omitted, could have been expounded in a few dozen pages. Since then, and more rapidly since 1943, the subject has grown into one which no single book can describe in its entirety. The primary stimulus was the increase in aircraft speeds; but a secondary stimulus, the belated realization of workers in pure science that the phenomena show fascinating differences from those of classical physics, has become equally important.

Profs. R. Courant and K. O. Friedrichs have not sought to cram into their review of progress in this field a vast mass of detail in an attempt to be comprehensive. They have chosen rather to present certain parts of gas dynamics, in a leisurely style, so as to make the result essentially a study in non-linear wave motion and the propagation of waves of discontinuity; there are appendixes on analogous physical problems, including waves in elastic-plastic materials. Engineers can go elsewhere for rule-of-thumb procedures, for accounts of experimental methods, or for the very extensive and valuable linearized theory of supersonic flow. The man of pure science may regret, however, the almost complete absence of reference to viscosity as an important property of gases.

Prof. Courant is the author of the celebrated "Methoden der mathematischen Physik", Vol. 2, which includes, in a precise and unified whole, a very large mass of general theory relating to partial differential equations. The present book incorporates from that work much of the theory of the quasi-linear hyperbolic problem. The preface regrets that a similar unification and completeness are impossible throughout the present subject, still in its infancy. The reader must rejoice, however, that the authors have not excluded special, more involved, methods which are as yet imperfectly known, since the frontiers of science are often thus isolated, and the interest of the fighting scientific worker lies mostly in such regions. In much of this we see the pen of Prof. Friedrichs, a doughty explorer of new paths.

The book is discursive, and aims principally at communicating the type of mathematical and physical behaviour encountered. It is not a reference work, so it should be read straight through, perhaps fairly fast. The clever student who does this, fresh from an undergraduate course of classical (linear mathematical physics, will be led safely into a clear understanding of what is now known on the non linear wave problems involved. Some of the ideas are complicated, and the pages of 'talk', free from formulæ, will be found among the most useful.

Unsteady rectilinear motion is covered very thoroughly, more so than in any previous book, and much of the critical work is done here, since the equations are fairly tractable in terms of Riemann's variables, while the deduced behaviour can mostly be taken over into more complicated systems. Thi work includes an extensive section on flame propagation.

Plane steady supersonic flow is then treated more briefly; its behaviour is qualitatively almost identica with the unsteady rectilinear motion if the second spatial dimension is equated to the time. The 'limi line' is put firmly in its place (below the importance attributed to it by some); its connexion with the hodograph transformation is displayed, though otherwise the latter is developed only for the purpose o finding simple exact solutions and for the graphical method of Prandtl and Busemann.

Shock reflexion is treated thoroughly. To reconcil theory and experiment on 'Mach reflexion' various postulates put forward include an expansion wav centred at the three-shock intersection. The Lava nozzle is discussed in detail, and it is shown what variety of shock configurations are possible therein as explanations of phenomena observed in choking and otherwise. A short section on axi-symmetrica flow and spherical waves, 198 references and an inde conclude the book.

The book, compiled and improved over a numbe of years, and given limited circulation in an earlier shorter form during the War, is most careful and accurate in its statements. However, in Fig. 41 the rear shock should curve in the opposite sense.

M. J. LIGHTHILL

Henry A. Ward, Museum Builder to America

By Roswell Ward. Edited by Blake McKelvey. (Rochester Historical Society Publications, Vol. 24.) Pp. xxiv + 297 + 15 plates. (Rochester, N.Y.: Rochester Historical Society, 1948.) N.p.

PROBABLY no individual has contributed more to the development of natural history museums throughout the world than Henry Augustus Ward, of Rochester, New York, who, even in his boyhood days, had acquired a roving disposition. At an early age he developed a keen interest in geology, and by dint of persistent hard work coupled with exceptional and unexpected opportunities he attained a position of eminence when he was comparatively young.

Early in the second half of the last century his passion for travel and for collecting rare specimens brought him to Europe, where he visited every museum he could find, returning to Rochester at the age of only twenty-seven with the finest collection of geological specimens in America. But this was only the beginning, and his love for exploration and the acquisition of new exhibits lured him to all parts of the world and provided geological and zoological specimens for Ward's Natural Science Establishment, which soon became a great emporium for the distribution of natural science material. Not only was this establishment famous for the provision of outstanding exhibits which led to the formation of many natural history museums, particularly in America, but it also became a training ground of outstanding men in various branches of museum technique who afterwards graduated to positions of eminence in the museum world. The later years of Ward's life were devoted to building up the most complete collection of meteorites in existence, a collection which is now preserved in the Field Museum, Chicago. The biography has been admirably written by his grandson, who has given us a complete and fascinating account of the life, work and achievements of a remarkable man of science, explorer and collector.

H. Shaw

Was ist Wahrheit in den Naturwissenschaften ?

Von Bernhard Bavink. Pp. 88. (Wiesbaden: Eberhard Brockhaus Verlag, 1947.) n.p.

IN this little book Prof. B. Bavink discusses first the meaning of 'truth' in science and, secondly, he criterion by which we determine what is true and what is false. On the first point he contrasts the ealistic view—that there is an external world which we examine and that our description of it is true if it corresponds faithfully to that world—with the positivist view that there is no world independent of our observations and that a statement about our observations is true if it is consistent with them all. As a compromise between these extremes he cites the Kantian doctrine that there is an external world but hat it is unknowable and all our knowledge is of our xperience. Prof. Bavink considers these attitudes in their relation to both general and particular scientific laws. Without definitely adopting any of hese views he points out that in practice we usually hink in terms of the first, and that in any case we must admit that scientific laws hold independently of the knowing subject. In the matter of the truth criterion he discusses the belief that mathematical and scientific theorems are conventions, and gives reasons for rejecting the positivist attitude in this matter. He finds the criterion of truth with respect to a scientific law in the convergence of different, and apparently independent, lines of research towards the same conclusion; the law is true in so far as this convergence is without exception.

While the book does not contribute anything essentially novel to the problems of which it treats, it is clearly and interestingly written, and sets out the various considerations in a thought-provoking manner. It may be recommended as a valuable stimulus to those whose minds are not yet made up on the subject.

H. D.

Einführung in die vergleichende Morphologie der Wirbeltiere

Von Prof. Dr. Adolf Portmann. Pp. 335. (Basel: Benno Schwabe und Co., 1948.) 28 Swiss francs.

DURING the nineteenth century many detailed works on comparative morphology were published, both for vertebrates and invertebrates. At the close of the century, morphology was frowned upon by the eager physiologists, experimental biologists, embryologists and geneticists, who maintained that morphology was worked out. But as usual the pendulum has swung back again, and there has been a realization that morphology is the fundamental study upon which the others are based, and that not less but more is needed.

Prof. A. Portmann's book is an up-to-date treatise on the elements of comparative morphology, based on a wide, accurate and detailed knowledge of the vertebrates. The work follows the usual course, dealing with the systems and organs of the body in turn, discussing their homologies, comparing fossil and modern examples, and assessing the value of their evolutionary trends. The excellent figures prepared by Frl. M. Stehelin are especially to be commended. Their very simplicity is pleasing, and her bold use of black and white is applied with an artistic merit rarely seen in text-books. The parts of diagrams in comparative series are numbered instead of lettered, so that the reader can test his knowledge. Is it to prevent his memorizing the numbers that in one series the numbers begin at the anterior, and in another at the posterior end ? A selected list of modern works is intended as an introduction to the literature, and there is an index.

N. B. Eales

Introduction to Emulsions

By George M. Sutheim. Second printing. Pp. viii + 260. (Brooklyn, N.Y.: Chemical Publishing Co., Inc.; London: Chapman and Hall, Ltd., 1947.) 21*s.* net.

THIS book is written in the first person in lecture style, and is, in fact, based upon lectures given at the Brooklyn Polytechnic Institute in New York. It is claimed to be written by a practical man for practical men, and, on that account, contains details and explanations which the chemist with a university degree will find superfluous. A bibliography is appended with 159 references; but no mention is made of G. I. Taylor's work on the physics of emulsion formation, nor of F. A. Cooper's work on size frequency analysis and the chemical engineering aspects of emulsion manufacture. Another extensive appendix gives the commercial name of 182 emulsifying agents produced in the United States, and lists their chemical name or formula, group and emulsion type and manufacturer. The uses of bentonite as an emulsifying agent is only lightly considered. The manufacture of a good emulsion is still somewhat of an art, and the comment that "you cannot learn to ride a bicycle by reading a book" still seems to hold for practical emulsion technology.

M. B. Donald

LIGHTNING AND SPARK PHENOMENA*

By DR. T. E. ALLIBONE, F.R.S.

Research Laboratory, Associated Electrical Industries, Ltd.

THE study of lightning has been allied to the study of the electrical spark discharge since the dawn of experimental science. Benjamin Franklin, the 'father of lightning', performed with electricity drawn from thunderclouds the same experiments that could be performed with electricity generated by a frictional machine. Hoffert demonstrated the multiple character of the flash by photography in 1889, and a few years later Walter showed that the electric spark could have a similar characteristic if the circuit constants were suitably chosen. In later years Schonland's extensive researches in South Africa, with the aid of the high-speed rotating camera, have greatly extended our knowledge of the lightning flash, and similar physical characteristics to those he has described have been found in the high-voltage spark discharge. Knowledge of both phenomena is, however, far from complete; but as lightning occurs so infrequently in Britain under conditions suitable for observation, it is perhaps more profitable in this country to contribute to the understanding of lightning by the indirect method of studying spark phenomena.

Sir George Simpson[1] made one of these first contributions, from which he deduced the polarity of thunderclouds. He observed the marked difference between the positive and negative streamers which pass between dissimilar electrodes charged from a Wimshurst machine—when the more highly stressed electrode was positively charged, sparks branched away from it; but when negatively charged, strong unbranched discharges passed between electrodes. On examination of more than four hundred photographs of lightning, he found more than 50 per cent exhibited branching away from the cloud and only three towards the cloud; 25 per cent showed unbranched discharges, but he recognized that branches on these might have been obscured by cloud or rain, so that at least a safe generalization was that the majority of flashes emanate from positively charged clouds.

This deduction was directly opposed to evidence of field changes at various distances from lightning flashes; Schonland and Craib[2], Wormell[3] and others following C. T. R. Wilson's pioneer work found the majority of lightning flashes brought a negative charge to ground, and Schonland correlated this with visual observations that a high percentage of these flashes branched downwards from the clouds. He also measured the magnitude of the point-discharge currents beneath a thundercloud and found these to be of such a polarity as to leave a positive space charge over the ground. This conflict of evidence prevailed until 1931, when the matter was resolved by a series of observations of spark discharges from a one-million volt generator in the High Voltage Laboratory of the Metropolitan-Vickers Company. Simpson's observations had been made with perhaps 50–100 kV. sparks; at much higher voltages the difference in appearance between sparks of opposite polarity is not nearly so marked as at low voltages, and frequently extensive branching of a negative discharge can be seen. The conditions for this were determined[4]; if an extensive positive space charge is built up in advance of the negative streamer, the latter will branch just as profusely as will a positive streamer, and then, to a first approximation, no difference can be observed by eye between positive and negative discharges. The fact that Simpson and many others observed a high preponderance of branched lightning discharges does not, therefore, imply that the discharges are of positive polarity.

Two years later, Schonland began his extensive researches into the nature of the lightning discharge as photographed by the Boys camera with rotating lenses. These showed the existence of a low-intensity discharge which travelled slowly from cloud to ground, followed by a high-intensity return stroke from ground to cloud, the speed of propagation of the latter being some 10–100 times that of the 'leader stroke', as Schonland named the pioneer discharge. This time interval between the initial appearance of the leader stroke leaving the cloud and the return of the 'main stroke' to the cloud immediately appeared analogous to the 'time-lag of flashover'[5] of a gap, so familiar to scientific workers engaged in transient electrical researches, and a search for the 'leader stroke/main stroke'[6] sequence in the laboratory with the aid of a rotating film camera was made. Sparks 40 in. in length were photographed with a camera capable of resolving times of the order of one microsecond, and the photographs showed unmistakably that as soon as the high-voltage source was connected to a point electrode, a discharge developed from this to ground, while a few microseconds later a fresh discharge passed between electrodes carrying such a large current that the potential of the point fell to very low value; the oscillograph showed that the 'time-lag of breakdown' was identical with the time interval between the onset of discharge and the occurrence of the main stroke as recorded photographically. Schonland described the leader stroke as a faintly luminous downward-moving streamer travelling with a speed of about 10^7 cm./sec.; when the ionized path is continuous between cloud and ground, a brilliant upward-moving streamer develops from ground to cloud at 10^9 cm./sec. From these early spark photographs and corresponding oscillograms, it was deduced that the leader stroke travelled between the electrodes at about 10^7 cm./sec., but the camera was unable to give information as to the speed of the return stroke.

The above results in the laboratory merely confirmed that sparks behaved in a manner similar to lightning flashes; but they were obtained for positive *and* negative discharges, whereas only negative lightning flashes have been observed with the rotating camera. The laboratory sparks were produced by the discharge of a condenser, and the way they were affected by the circuit constants was studied[7]. It was found that with large values of circuit resistance the 'leader stroke' in its progress from the high-voltage electrode to ground was reinforced intermittently by fresh charges brought from the high-voltage source, the time interval between these stepped processes being a measure of the recombin ation of ions. Undoubtedly the stepped process also depended upon the circuit resistance and therefore on the time-voltage characteristic of the applied potential, so that it is arguable that the stepped character of the lightning leader stroke may also be due to the 'resistance' of the current-carrying path within the cloud. More laboratory work is needed to give a better understanding of the advance of the leader stroke.

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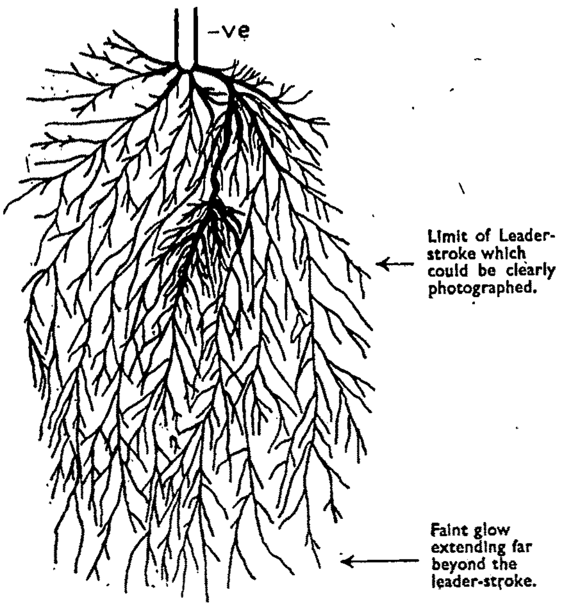
* Friday Evening Discourse at the Royal Institution, delivered on March 12, 1948.

An interesting difference was found between the positive and the negative discharge[8]. In general, the positive leader stroke progresses most of the way from a high-voltage (positive) point electrode to a grounded plane electrode; but in general as a negative leader stroke progresses from a high-voltage (negative) point electrode, it is met in mid-gap region by a positive leader stroke rising out of the grounded plane. If the field-strength at the positive grounded electrode is artificially increased—as by providing pointed electrodes projecting from the grounded plane—the upward positive leader stroke development is favoured, and the meeting point between the two leader strokes is raised nearer to the negative electrode, until, if the grounded positive point is high enough above the plane in relation to the inter-electrode gap, the positive leader dominates the picture to the almost complete exclusion of the negative leader from the high-voltage electrode. If this is true also for lightning, discharges at the top of high buildings should be predominantly discharges *from* the buildings to cloud[8]; this phenomenon was, in fact, observed from the top of the Empire State Building, New York.

This same characteristic must be the cause of the prevalence of a high percentage of negative discharges being recorded on transmission lines; the advancing lightning flash, if of negative polarity, is 'attracted to' a high tower or line by virtue of the ascending positive leader stroke rising from the line to meet the flash. There are in existence a number of photographs of lightning which provide evidence in favour of this, though no actual record exists taken by a rotating camera of flashes to towers or moderately tall buildings; the deduction is based primarily on the laboratory spark photographs, and the only doubt lies in the exact magnitude of the effect on the statistics of lightning strokes to lines.

Further work by Schonland and his co-workers established the fact that the leader stroke discharge was a complicated process; a streamer develops from the cloud in a series of steps separated in time by about 50 microseconds, and at each step the discharge is advanced towards ground by a discharge path more luminous than the remainder of the discharge; it was suggested by Schonland[9] that the steps were preceded by a 'pilot' streamer, too feeble to photograph, advancing continuously from cloud to ground with a speed of about 10^7 cm./sec. As mentioned above, whether it advances continuously or not may depend on circuit constants, but whether it exists or not is of great interest.


-ve
Limit of Leader-stroke which could be clearly photographed.
Faint glow extending far beyond the leader-stroke.

Development of pilot streamers ahead of the 'leader stroke' to the spark discharge

Now it had been known for many years that not even quartz lenses and fast photographic plates could record all the details of a spark which can be seen by eye. For example, in the 1931 experiments[4] on branching of negative discharges, a technique had been used of arresting the discharge by providing in the circuit an alternative spark path having a time-lag of spark-over just a little shorter than the time-lag of the gap under close observation. Under these conditions the great glare of the spark is eliminated from the gap, across which only a partial spark is developing, and a most extensive tracery of discharge was visible to the eye but not recorded photographically. In a recent effort to establish the existence of the 'pilot' streamer, these old experiments were repeated[10] with a new photographic technique; bromide or gaslight printing paper was set up in a vertical plane between the high-voltage electrode and ground, so that the arrested discharge played over the surface of the paper and left a latent image. This probably was as extensive as any discharge the eye could see; a very extensive fine tracery was recorded many inches ahead of the 'leader stroke' which the rotating film camera could record, and the leader stroke is now discernible, not as a discharge advancing into virgin air, but as a canalizing of the tenuous discharges, possibly when the current density reaches a certain value. The accompanying sketch taken from one of the photographic prints shows the details better than can be brought out by direct reproduction of the original prints. Clearly this tracery could never have been detected in the lightning flash photographs, but it provides very strong evidence for the correctness of Schonland's 1938 postulate of a pilot streamer. With what speed this diffuse discharge advances into the virgin air is not known, nor at what current density the canalization of the discharge occurs; and much more experimental work in the laboratory is needed to take the subject a step further.

Another problem of the thundercloud which can be studied in part in the laboratory is the potential necessary to cause breakdown. Early estimates of potentials of clouds with respect to ground were based on the known breakdown potential of air between pointed electrodes at rather small spacings; but there is insufficient information about the breakdown potentials of very large gaps to say whether the same gradients are necessary for a discharge to start. What information exists relates to impulse voltages, but the breakdown laws under constant voltages would be much more interesting, since breakdown within the cloud must begin by discharge between oppositely charged volumes of cloud maintaining their charge steadily for some seconds at least.

(The Discourse was illustrated by a number of experiments with a 500,000-volt impulse generator; in the darkened auditorium the positive and negative leader strokes were shown at different stages of development, the influence of electrode shape on leader strokes was demonstrated, and examples of the 'protective action' of a pointed electrode on the space around it were shown. The influence of the nature of the terrain on the incidence of lightning was illustrated with a sand tray model.)

[1] Simpson, *Proc. Roy. Soc.*, A, **111**, 56 (1926).
[2] Schonland and Craib, *Proc. Roy. Soc.*, A, **114**, 229 (1927).
[3] Wormell, *Proc. Roy. Soc.*, A, **115**, 443 (1927).
[4] Schonland and Allibone, *Nature*, **128**, 794 (1931).
[5] Allibone, Hawley and Perry, *J. Inst. Elect. Eng.*, **75**, 671 (1934).
[6] Allibone and Schonland, *Nature*, **134**, 736 (1934).
[7] Allibone, *J. Inst. Elect. Eng.*, **82**, 513 (1938). Allibone and Meek, *Proc. Roy. Soc.*, A, **166**, 97 (1938).
[8] Allibone, *J. Inst. Elect. Eng.*, **82**, 513 (1938).
[9] Schonland, *Proc. Roy. Soc.*, A, **164**, 132 (1938).
[10] Allibone, *Nature*, **161**, 970 (1948).

THE HISTORY OF ALUM

A HISTORY of almost any common material could be made the framework of a general history of civilization, both in its political and economic aspects, and hence could serve as a kind of heuristic method of teaching general history. This would be a very uneconomic method, since every specialist author would have to repeat a large mass of material already traversed by every other author; and it may be suggested that a historian of science or technology might profitably assume that the political history (taking the name in its widest sense) with which his studies bring him more or less intimately in contact can be sought elsewhere. There are notable exceptions to this; some works on the history of science, such as Meyer's "Geschichte der Botanik", deal in detail with various aspects of general history in a way which makes them still very useful to the professional historian when he happens (as is rarely the case) to know of their existence. The history of alum is a subject which lends itself very well to a plan of fitting it into a general picture of the conditions and movements of the times traversed, and an author working up this subject has a good opportunity of doing this if he feels inclined towards it. It may be said that Dr. Charles Singer has, in fact, incorporated a substantial amount of such material, including a general history of the alum trade, in his recently published account*, and this will make it especially valuable and interesting to the general historian.

An author taking up a study of the history of a material will find that his subject will fall into one or other of three large groups. In the first, the basic information is already well known and exists in adequate detail; such, for example, would be the history of iron. In the second, practically no coherent and collected information is available, and the author is compelled to go through an immense number of likely and unlikely sources, assemble a mass of unconnected and generally contradictory statements, and then attempt to reduce the material to some kind of order, carefully avoiding any tendency to arrive at general conclusions before this has been done, so as to prevent the possibility of making a framework into which the material must, at all costs, be fitted. In the third group, the material has already been treated, but imperfectly and often at a date when important information relevant to it was not available. It may be suggested that the history of alum belongs to this third group. Its main outlines have been drawn by such authors as Beckmann and Heyd, and the main sources to which a modern author might turn for his materials have been stated by them. It is then essential to re-examine the data and, in completing it and adding what is new, to draw more correct conclusions. Beckmann, for example, although he makes use of nearly all the material now available, drew a completely incorrect conclusion from it, namely, that alum was unknown in antiquity.

The history of science can be presented in various ways. Those who have read the previous publications of Dr. Singer will be aware of the general guiding principles which he follows, and will know what to expect. An author may confine himself to an account of his subject proper, or he may include what may be called the external machinery of science, such as the foundation and growth of scientific societies, the relation of the personalities with whom he deals with religion or politics, when they happen to have had such relation, and in such cases to deal with these wider aspects of the subject. Some sciences lend themselves more easily to such treatment; astronomy in particular is one, and such personalities as Galileo offer an almost inexhaustible plenitude for repetitious treatment in such a way. This type of writing, however, is more suited to the general historian, or the author who sees in the history of science an opportunity of conveying to his readers, many of whom he may hope are relatively uninstructed, his cherished beliefs or creeds. Such writing is not in the category of history of science proper, and does not advance in any way the study of this subject.

In his publications Dr. Singer has followed a middle path. He has available a wealth of detailed knowledge such as the specialist would use in producing a severely professional account of the subject, and at the same time he has a feeling for the picturesque and attractive marginal aspects, in particular of the value of illustrative material, which make his works so attractive and readable. Much of this material is drawn from little-known and inaccessible sources such as manuscripts or books, the existence of which is unknown to the general historian of science. In the present work, in the preparation of which Dr. Singer has been fortunate in being able to draw on such sources, he has given a selection of illustrations, including many in splendid colour, which puts the book into a class of the highest interest, and makes it, even to those not much drawn to the general story of alum, one which must have a lasting value as a fine book, in the production of which the artistic craftsman has played a notable part. In the appearance of the book, as a book, everyone concerned must take a justified pride. Dr. Singer always takes care to accompany every illustration with an adequate description, and this feature of his authorship is fully continued in his latest work.

The book is divided into five main parts: antiquity, medieval technical and chemical lore, medieval trade, monopolies and empirical methods, and the rise of scientific industry. As stated above, although the guiding theme is the history of alum, an opportunity is taken in each section of presenting information from other departments of knowledge, which makes it, in itself, a valuable source for the student of each period as a whole, although the quotations from texts are, in the main, those dealing with alum. There are 361 references collected at the end of the book, an arrangement which, although perhaps necessary on æsthetic grounds, is very inconvenient to the reader in search of information. There has been a tendency among old-fashioned authors, particularly in Britain, to show a degree of shame in exhibiting detailed knowledge; this is perhaps a relic of their own school days, when such accidentals of scholarship were looked upon with disfavour. Such reticence is out of place in modern works on the history of science, when precise documentation is necessary and expected. Dr. Singer, as usual, takes a middle way, giving us in many cases only the title of the work, without a page reference. His bibliography is very satisfactory; only in one or two cases would one have wished for slight additions, as when he refers to D'Arcy Thompson's "Glossary of Greek Fishes" for the murex and omits to mention the special treatise by Moatsou (Alexandria, 1932); but even the narrowest specialist will find himself baulked at every turn in his search for omissions of sources in Dr. Singer's impressive list.

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* The Earliest Chemical Industry: an Essay in the Historical Relations of Economics and Technology illustrated from the Alum Trade. By Charles Singer. Pp. xviii+337. (London: Folio Society, 1948.) £10 10*s*. 0*d*.

A reviewer is expected to find at least a few faults with every work, and to show good faith to his kind, the present writer will hurry over a few slight trivialities of this sort. The *bain Marie* of the Greek-Egyptian chemists was not a water-bath, and the original figures of the *kerotakis* would have been better than the supposed reconstructions (p. 10); *trichitis* (p. 19) is not alum, as the author knows in another place; *realgar* is not red sulphide of mercury (p. 52); 'saturated alkali' (p. 39) is probably ferrocyanide. Agricola was not a technological expert and cannot be expected to understand all he describes, and his portrait is not contained in any original edition of his book the reviewer has seen (pp. xv and 227); phlogiston is named before Stahl's work of 1703 (not 1702, as stated) (p. 249), and the dephlogisticated part need not be a 'fixed' body—in sulphur it was sulphuric acid; Lavoisier did not think the alkalis were oxides of unknown bases (p. 267); Davy's first name for potassium was 'potasium' (p. 268); Wöhler's aluminium was not very impure, and the metal was also obtained by Ørsted in 1826 (p. 268). These are all trifles. The style of the book is clear, concise and attractive; only in one or two cases has the author been hypnotized momentarily by his text, as in the Germanic "they dyed always the yarn before weaving" (p. 265). The reader should not omit to look up the references, where additional information is often to be found.

The story presented by Dr. Singer is, in brief, the following. Alum was known to the ancient Egyptians and Assyrians, who used it medicinally and in magic. Its use as a mordant in dyeing is described at least as early as Pliny (who, by the way, gives the first record of galls as an indicator long before Fallopia, p. 244), and from that time the history of dyeing is intimately connected with the history of alum, so that the book is valuable to those interested in dyes. It is shown that knowledge of chemical substances in the classical period was much more extensive than is sometimes thought, and not a few, alum notably, were known in quite reasonably pure condition. An account of ancient baths is given. Puteoli (modern Pozzuoli, on the Bay of Naples) was a source of alum, its baths long being famous. The information about technical arts in the medieval period is drawn from several treatises compiled in that period by non-literary authors, giving recipes for dyeing, etc.

After a concise account of Arabic alchemy (in which the strange difference between the "Secret of Secrets", an alchemical work thought to be by al-Rāzī, from his medical works is not noticed), and its continuation as the so-called Latin alchemy, Dr. Singer deals with lapidaries and handbooks such as the "Hausbuch" and the problematical "Plictho". A long and detailed account of medieval trade brings together much information about the rivalry of the Italian centres. In this period the import of alum from the East increased, although European alum, less esteemed than the Asiatic, was still made in significant amount. Exports from the Eastern Mediterranean, Phocœa, and the Black Sea became important, and there is an interesting account of Phocœa in Pegolotti. The rise of Venetian trade under a grant of privileges in the Byzantine imperial domains is linked with the influence of the Crusades. In the fourteenth century Florence had a trading supremacy, and the connexion between alum and wool turned a new corner on the way of technology and trade. Western sources of alum were now productive.

In 1461 large quantities of alunite, a mineral from which alum can be made, were found at Tolfa in Papal territory, and the famous Papal alum monopoly was established mainly by the efforts of Giovanni de Castro and Pope Pius II. The profits of the trade helped to subsidize the war against the Turks. The purchase of 'infidel' alum was anathematized, and indulgences were based on such motives. It is perhaps not generally known that the famous indulgence on which Luther acted was of this character. The monopoly of the Papal alum factory was later broken by the northern countries making alum from other sources. A financial contract between the Medici and the Apostolic Chamber in 1466 began a period when alum was not infrequently mingled with the hopes of mankind for felicity in the hereafter. This story of the Papal monopoly is fairly and clearly told; it had interesting ramifications. The works at Pozzuoli are well described, the illustrations of this volcanic region being most interesting. Some splendid coloured plates are reproduced from the work of Sir William Hamilton, who visited the district in his capacity of British Ambassador to Naples in 1764, as well as an interesting drawing by Madeleine Hortemels (aged seventeen) of the Grotto del Cane in a guide book of 1707. For this source of alum we have the well-known book "Metallotheca" by Michele Mercati (1717).

The working of alternative European sources of alum in the seventeenth and eighteenth centuries is described, with an interesting excursion on the history of mining (which is just beginning to pass out of the second category mentioned at the beginning of this review) and mineralogy, including mineralogical collections and museums. Alchemy was now giving way to chemistry, and for that reason the alum industry, which is perhaps the earliest chemical industry of all, could become scientific. Dyeing also became scientific, and the description of the sources and uses of the natural dyes is one of the most interesting sections of the book. The British alum industry had its rise in the exploitation of the carboniferous shale of the Yorkshire coast and Scotland. Peter Spence (1806–83) was the pioneer of this industry, and his descendants are among the premier alum manufacturers of the world. The preface of Dr. Singer's book, by Mr. Derek Spence, explains how it was wished in 1946 to celebrate the hundredth anniversary of the company by a lasting memorial to Peter Spence, and the present splendid volume is the result. In achieving their object they have at the same time, thanks to the unrivalled knowledge and literary skill of Dr. Singer, added a lasting contribution to the history of science for which they deserve the warmest thanks of all those interested in its welfare. This book will take its place among the great classics of the subject. J. R. PARTINGTON

OBITUARIES

Dr. A. D. Imms, F.R.S.

AUGUSTUS DANIEL IMMS, who died on April 3, 1949, at the age of sixty-eight, was well known to zoologists and entomologists throughout the world, and there are few, if any, modern zoological text-books with a wider circulation than his famous "General Text-book of Entomology". Imms graduated at Birmingham in 1903 and shortly afterwards went to Christ's College, Cambridge, as an 1851 Scholar. Here he obtained a B.A. degree by research in the days before the institution of the Ph.D., and came much under the influence of Dr. David Sharp and Sir Arthur Shipley. From being an assistant demonstrator in zoology under Prof. Gamble at Birmingham, he went to India in 1907 as professor of biology in the University of Allahabad. Later he was for three years forest zoologist to the Government of India.

These seven years in India influenced profoundly his further development as a zoologist, adding to his sound morphological attainments breadth of view in biology and an understanding of the complexity and urgency of the problems of agricultural and economic zoology in the tropics. While in India, Imms produced his best research work, among his papers at this time being a fine study of the morphology and biology of *Archotermopsis*, a primitive member of that most fascinating group of insects, the termites, the stupendous colonies and elaborate social organisation and caste system of which have been the marvel of zoologists since the end of the eighteenth century when entomologists first began to explore systematically the faunal riches of the tropics.

But it was not as an original investigator that Imms was to make his real mark. In 1913 he returned to England as reader in agricultural entomology in the University of Manchester, and he there commenced work on the great "General Text-book" already referred to. This was held up by the First World War and was not finished until 1925, by which time its author was chief entomologist at the Rothamsted Experimental Station. The text-book, a monumental work, has gone through many editions; it is in every way comparable with and in many respects superior to its famous predecessors, Packard's "Text-book of Entomology" (1898), Henneguy's "Les Insectes" (1904) and Berlese's "Gli Insetti" (1909). In this book Imms found full scope for his particular combination of qualities: an encyclopædic knowledge of his subject, a meticulous accuracy, a sound morphological insight and a well-balanced critical faculty. Indeed, it is the critical acumen and the balance of the book which are perhaps its most outstanding features, although the balance was somewhat upset in later editions by the immense growth of physiological investigation, a field in which Imms was less especially interested and which he left to others to summarize in text-book form. Imms was also the author of other valuable books, notably "Recent Advances in Entomology" (first edition 1930) and "Insect Natural History" (1947), and he produced the excellent articles on entomology in the "Encyclopædia Britannica".

Imms was elected a fellow of the Royal Society in 1929, and in 1931 he went to the Department of Zoology at Cambridge as first incumbent of the newly created readership in entomology. Here he built up a new sub-department and, during his time as reader, served on the Council of the Royal Society. He was president of the Royal Entomological Society of London and of the Association of Economic Biologists. When the main burden of text-book writing and the work of organising the sub-department was ended, Imms returned once more to personal research, and produced some valuable memoirs bearing particularly on morphological problems fundamental to questions of the ancestry of insects and phylogenetic relationships of the main orders. These included work on the growth processes in insect antennæ, on the constitution of the maxillæ and labium in the Mecoptera and Diptera—a study which throws a great deal of light on the relationships of the latter order—and an admirable short paper on the biology and relationships of that most puzzling insect *Braula cæca*, the 'bee louse'.

Personally Imms was reserved, and probably few people knew him intimately. Although he stimulated an immense quantity of valuable research through his writings, he was sometimes apt to appear discouraging to undergraduates, seeming on occasion to dishearten and chill by an apparent lack of enthusiasm. But in reality he was an excellent judge of promise in young research workers; he knew the real investigator directly he saw him, and he recognized and appreciated the type which would respond to criticism in the right way and whose ardour nothing would damp. A student of this quality could count on him for unswerving support and friendship.

Imms was elected a Fellow of Downing College in 1940, and his work for the College and his relations with its society constituted perhaps one of the happiest episodes of his career. When the Second World War came and the younger Fellows of the College left for war service, he unhesitatingly undertook the arduous duties of bursar and steward, thus entering on work with which he was previously altogether unfamiliar. Nevertheless, he made a real success of it and impressed all his colleagues with the rapidity and efficiency with which he got things done; he was particularly clever in making the most of the scanty time at his disposal, and it was astonishing how he contrived to carry this heavy burden of College work without apparently decreasing the time available for his scientific activities and without ever becoming in the least 'ruffled' over the sometimes irksome jobs which arose in the course of his duties. On his retirement from the University readership in 1945, Imms received the honour of election to an honorary fellowship at Downing. He was also honorary member of a number of learned societies in foreign countries, including France, Holland and Finland. The climate of Cambridge never suited Imms, and on retirement he therefore settled in Devon in the hope that he would enjoy better health there. He soon began to take an active part in local affairs and to enjoy his garden and the new duties and obligations which life in a small rural community involved. But further illness soon supervened, and his last years were, in the main, a brave struggle against persistent and painful ill-health, in spite of which he managed to accomplish much valuable work in the way of revising and preparing new editions of his books.

Imms married in 1913 Miss Georgina Mary French, of County Tyrone, who, with their two daughters, survives him. W. H. THORPE

Mr. W. A. Knight

MR. WILLIAM A. KNIGHT, the first headmaster of Sexey's School, Bruton, who died on April 11 at the age of eighty-two, was known as a leading educationist. From 1903 for some years he was a member of the Somerset Education Committee; during 1920–25 he served on the first Burnham Committee; in 1924 he became president of the Incorporated Association of Headmasters; and in 1928 he was elected to represent the English secondary school headmasters at the Bucharest Conference. He was an honorary M.A. of the University of Bristol, honorary associate of University College, Reading, and a J.P. for Somerset.

The opening of Sexey's School in March 1891 was due indirectly to an Elizabethan, Hugh Sexey (or Saxey), the founder of Sexey's Hospital, Bruton, certain accumulated funds of this institution being appropriated for the purpose. The Right Hon. Henry Hobhouse was chairman of the school governors until 1930. Mr. W. A. Knight, a native of Castle Cary, was only twenty-four at the time of his appointment, and during the thirty-six years until his retirement in 1927 he developed a school with highly distinctive traits. Bearing in mind a fundamental idea of the promoters to impart a strong practical and scientific bias to the curriculum, the youthful headmaster became a pioneer in the development of science teaching in schools. General elementary science, natural history, chemistry, physics and botany all found a place in the curriculum. A generation or so later, the importance of biological science in schools received general recognition. Up to the present time numerous Old Sexeians (many of whom are now well known in science) have taken a leading part in organising and developing biological work in schools, universities and research stations, both at home and overseas.

Gradually, under Mr. Knight's guiding hand, the school became known in the provincial universities, at the Universities of Oxford and Cambridge, and in Continental universities: so quick in its own soil was this acorn from a native Elizabethan oak. The record of Sexey's School shows that a proper emphasis on science in school teaching need not exalt material values at the expense of the spiritual. It is likewise remarkable that so many of Mr. Knight's pupils have developed strong literary and artistic tastes. The diverse fields in which alumni of this school have achieved distinction include the Church, literature, public affairs and administration.

In this little school, with her native human material and "Somerset's green lanes around her", the gifted headmaster was able to find full scope for his remarkable ability as a teacher, his organising genius and his inspiring ideals of attainment and character. Under Mr. Knight's tutelage one learnt as much out of school as within its walls. How, for example, could one remain indifferent to local history and topography when botany rambles with him led to such fascinating haunts as Wyke Champflower, Kingsettle Hill, Stourton Tower, Godminster and Holywater Copse?

The perennial charm and stimulating force of Mr. Knight's personality had much to do with the success of Sexey's School. He took a vivid interest in his pupils and their doings, both at school and afterwards. His memory of anything concerning them was amazing. In an unsurpassed measure he earned and kept the esteem and strong affection of his pupils, to whom he was always a personal friend as much as the ideal headmaster. In the words of a versatile old pupil (R. W. Gregory), who achieved eminence as an electrical engineer:

> You made us men, we boys of your own breed;
> And like the glowing steel, our mother wit
> With cunning hand you hammered into shape,
> And tempered for keen service to our kind.
> You made our School; a thousand boys and more
> You showed the way of life; and thorough men,
> Through all the continents of mother earth,
> Hold you in honour.

JOHN READ

PRESENT-DAY educationists, if they had had the opportunity, would have studied with interest, and acclaimed many points in, the pedagogical approach and the school organisation of Mr. Knight; for in many ways it was unique. For example, he would never allow 'holiday tasks', 'lines' or being kept in school after hours as a means of punishment. Both monitors (as they were then called) and staff could punish by a system of exclusions—exclusion for a definite period (which varied with the crime) from the gymnasium, the museum, the reading room, the fives courts, and even from the class-room (out of school hours). So boys never ran the risk of their literary appreciation being undermined through having to write under duress interminable quotations from authors; they always enjoyed complete freedom during their holidays: but the 'exclusions' proved to be so inconvenient that any sensible culprit thought twice before repeating his offence.

The school year was also divided into four terms, so that half-term rests were not necessary, and fatigue was reduced.

Mr. Knight also seemed to have a genius for choosing his staff to the best advantage. He was not easily bemused by high academic honours; capacity for work and the full recognition of the value of *esprit de corps* played important parts when he made a choice. Mr. Knight himself recently told me that, other things being equal, he would not mind whether his assistant was a 'pass' or an 'honours' man. One of his assistants recently coined the expression "the Sexeian habit"—the habit for hard work.

As Prof. Read writes, his "memory of anything concerning [us] was amazing"; and whenever we met him afterwards (no matter how many years had elapsed between), he was the headmaster, we the boys. In 1947, when the school honoured me by inviting me to present the prizes on Speech Day (well-nigh a quarter of a century after I had left the school), he took my hand and, without so much as a 'how d'you do', said: "But you have changed; you were always so very thin".

He was a great headmaster to whom science owes a considerable debt. He had no time for 'frills'; he got on with the job. The present headmaster, Mr. W. E. Page, writing to me recently, said: "We buried him, as he wished, with a minimum of ceremony and in the presence of scarcely a dozen people. It was moving in its stark simplicity." L. J. F. BRIMBLE

Mr. J. Hornell

MR. JAMES HORNELL, who died at Hastings on February 24 at the age of eighty-three, was a pioneer. He was one of the first marine biologists and fishery naturalists to be employed as such, and his experience of the fisheries of warmer seas placed him in a unique position for many years. Educated in Scotland and at the University of Liverpool, his early experience was gained on a fisheries survey of the Channel Islands, where he met his wife. Shortly after this he left England, and in 1904 was appointed marine biologist to the Government of Ceylon and four years later in the same capacity to the Government of Madras. Here he began a connexion with tropical seas which occupied the greater part of his working life.

In those years his efforts were mainly directed to the practical application of his investigations, and his elucidation of the cause of a decline in the Ceylon pearl oyster fishery, recommending action which brought back a substantial measure of prosperity, is an outstanding example of his achievements in this direction. Later, he made many other attempts at fishery development, among which may be mentioned his plea for the culture of fish in ponds and lagoons. In urging work of this sort, he produced a report on the conditions under which fish are farmed or cultured at Arcachon and Commachio, recommending similar action in India. The time for what we recognize as developmental and operational research was not yet, however, and the will and resources to implement his schemes were not forthcoming in a way that was worthy of his proposals. In addition to the presentation of development schemes and the day-to-day distractions of administration which became his lot when he was promoted to director of fisheries in 1918, he managed to do a considerable amount of descriptiv biology. It is, indeed, a matter for remark that living so far away from the academic contacts tha might have helped him, he dealt with these studie so competently. There is no doubt that, had h remained in England, his contribution to mor fundamental fishery research would have been outstanding.

A rather special aspect of his scientific outlook arose from the application of a fisheries ecology which included men and gear in relation to the fish they pursued. This led him to produce interesting descriptions of fishing boats and gear before he retired from the Madras Government service in the early 'twenties and which culminated in his classic "Water Transport its Origins and Early Development", published only two years before his death. After he left India, he made many visits to British Colonial Dependencie and Mandated Territories, from which emerged a series of short fishery surveys of great value. In 193 he went to live in Hastings, which remained his home for the rest of his life. Here he entered into the scientific life of the town, studying and describing the structure of local fishing boats and giving hi welcome assistance to the Sussex Sea Fisherie Committee.

Hornell was gifted with a power of lucid exposition evident in all his many publications, making them both a pleasure to read and models of style to those who come after him and regret his passing.

R. S. WIMPENNY

WE regret to announce the following deaths:

Sir Wyndham Dunstan, K.C.M.G., F.R.S., directo during 1903–24 of the Imperial Institute, on April 20 aged eighty-seven.

Prof. F. S. Kipping, F.R.S., emeritus professor o chemistry in University College, Nottingham, o April 30, aged eighty-five.

Dr. W. J. Perry, lately reader in anthropology i the University of London, on April 29, aged sixty-one

Sir Robert Robertson, K.B.E., F.R.S., formerly Government chemist, on April 28, aged eighty.

NEWS and VIEWS

Prof. Doris Mackinnon

PROF. DORIS L. MACKINNON, who retires from the chair of zoology at King's College, London, at the end of the present session, has held the post since 1927, when she succeeded Dr. Julian Huxley. She joined the staff of King's in 1919 when the late Prof. A. Dendy was head of the Department, and endeared herself to generations of students by her professional competence and her sympathetic, wise and helpful guidance. Prof. Mackinnon has published many noteworthy papers on her work, which deals almost entirely with parasitic Protozoa (especially flagellates and Sporozoa). During the First World War she joined the team of workers engaged in the diagnosis of amœbic dysentery and intestinal protozoal infections for the War Office and Medical Research Committee (now Council). When she went to London after the War, she soon established a centre of research in protozoology—for years the only zoological (that is, non-medical) centre of the kind in Britain. By her teaching and research and the work of her pupils she has thereby done much to advance the subject and her publications include many solid and permanent contributions to protozoology. As too frequently in academic appointments, the responsibility c administration tends to make inroads on time fo research; but Prof. Mackinnon kept up a constan flow of publication and gave intercollegiate lecture of characteristic lucidity and thoroughness. In paying tribute to her gifts as a teacher, it would no be out of place to mention the admirable series o broadcast talks on natural history given to schools Her services on the University and College Board and Faculties were particularly appreciated, as sh brought to them a breadth of outlook, sound judgment, scrupulous thoroughness and an altruisti approach not invariably observed on such bodies Fortunately her retirement does not mean that sh will cease her zoological work, and her colleagues an friends will still be able to enjoy her urbane an delightful companionship.

Silver Jubilee of the Indian Chemical Society

THE *Journal of the Indian Chemical Society* is now so well known that many will perhaps be surprised to learn that the Society is only twenty-five years old. The silver jubilee was celebrated at the annual meeting held in Allahabad on January 3 last, when messages of congratulations were received from sister societies in other countries, fittingly headed by one from the oldest Chemical Society, that of London, which recently celebrated its centenary. As was natural, many tributes were paid to the first president, the late Sir Prafulla Chandra Ray, to whom more than to anyone else must be given the credit for the development of chemical research in India. Some account of India's contributions to chemical science is given in a jubilee publication which contains photographs of the past presidents and honorary fellows. In the course of his address, the president, Prof. P. Ray, wisely laid particular emphasis on the importance of fundamental scientific research and to the lack of inspiring teachers and investigators in the schools and universities. According to Prof. Ray, the situation in this respect has recently become worse owing to the departure of many university teachers to take up administrative posts in Government departments. This is a danger present not only in India. Prior to delivering his address, the president announced the election of five honorary fellows, among whom we were glad to note the name of Sir Robert Robinson. We feel sure that, when the Society celebrates its golden jubilee, its fellows will look back with pride and thankfulness to those who served it during its first twenty-five years.

Men, Managers and Machines

IN his monograph "Scientific Management" (Monographs on Higher Management, No. 9, Department of Industrial Administration, Manchester Municipal College of Technology; May 1948), Mr. G. Chelioti urges that the essence of management is the art of getting things done through the agency of other human beings, and that management itself is incapable of becoming a science. He regards science as the foundation and the provider of the tools of industry, and the technician as the primary servant of science in industry; but he points out that the technician cannot manage human beings by means of his technology and that the manager dealing with a technical problem becomes a technologist for the time being. In urging this clear separation of the two functions of dealing with human beings and with technical problems or machines, Mr. Chelioti maintains that the undue domination of industry in the nineteenth century by the new element of modern technology, and the failure to regard industry as the servant of humanity and to consider sufficiently the human beings employed, was responsible for the revolt of the human spirit against subordination to the machine which we are still experiencing in spite of a more enlightened managerial outlook. Mr. Chelioti also reminds us that the current attitude of society was at least as much responsible for the revolt as the contemporary employers or managers, and his words should be carefully weighed in the discussion of the question of human relations in industry to-day.

Fungi as Human Pathogens

IT is fortunate that in Great Britain there are relatively few outbreaks of human disease caused by fungi. Such maladies are, however, much more common in the warmer parts of Europe and in the United States, where considerable study has been devoted to the diseases and their causal agents. Results of these investigations are published in the journal *Mycopathologia* (Dr. W. Junk, den Haag, Holland). The subject brings its own problems, particularly in naming and classification, some of which are discussed in a paper by T. Benedek (4, Fasc. 3; Dec. 1948). It is concluded that the dermatophytes cannot well be classified by the usual methods of botanical mycologists, and that it is preferable to retain the four form genera originally suggested by Sabouraud. This retains the tradition of the Fungi Imperfecti, where species are classified merely from the form of their asexual spores until the sexual forms are discovered. Mycologists will also find, in the same number of *Mycopathologia*, useful papers on the yeast flora of grapes, must and wine (R. Ciferri and O. Verona), and of the 'vegetation waters' separated from olive oil (R. Ciferri, O. Verona and F. Luparini). The blastomycetic microflora of fermenting tobacco is described by M. Giovannozzi. An investigation of antibiotic substances against Gram-negative micro-organisms has been made by G. Magni and A. Villa, and G. Magni has studied the biological significance of the pseudomycelium of asporogenous yeasts. W. J. Nickerson and O. F. Jillson also discuss the interaction of pathogenic fungi in culture, with reference to cell division in the dimorphism of pathogenic fungi. Specialist papers on mycopathology also appear; it is in no invidious sense that they are not reviewed here in detail. There are far more general mycologists than mycopathologists in Great Britain; but the former will nevertheless find much of interest in *Mycopathologia*.

Taxonomy of the Fungi

IN the issue for June 1948 of the *Transactions of the British Mycological Society* (31, Parts 3, 4) there are several papers which help to clarify the systemic positions of many fungi. A. A. Pearson and R. W. G. Dennis have reviewed the validity of the 1,870 specific epithets contained in the latest authoritative work on Agarics (Rea's "British Basidiomycetæ"). They have excluded synonyms, names attached to inadequate descriptions, and other variants of doubtful nomenclature, leaving a total of 1,234 species. Boletales have similarly been reduced from 70 to 47. The valid species are listed with short notes (pp. 145–190), and field mycologists should be grateful to the authors for the removal of such an incubus. This clarification has involved a re-examination by R. W. G. Dennis of several little-known agarics from the herbaria of Berkeley, Cooke and Massee; 29 of these are described in relation to the shorter list (pp. 191–209). Special groups of fungi have also been studied. The late T. Petch provides a revised list of British entomogenous fungi (pp. 286–304), including a new species, *Verticillium menisporoides*, found on spiders in Suffolk. Fungi which are associated with lichens have not hitherto been investigated very intensively. W. Watson lists (pp. 305–339) a large number of these, with notes on their characters and distribution. The Society's "List of Common British Plant Diseases" is kept up to date by the publication of emendations. A collection of these, designed to supplement the third edition of the List, appears in the present number of the *Transactions* (pp. 340–342). A new species of *Pyrenophora* from Italian ryegrass is described by

H. F. Dovaston (pp. 249–253). It is *P. Lolii*, and is possibly the perithecial form of *Helminthosporium siccans*. Other new species are described by N. C. Preston (pp. 271–276)—*Myrothecium jollymannii* from dried tobacco leaves in Nyasaland, and *M. striatisporum* from clay soil in New Zealand.

Establishment and Care of Lawns

AMONG the more general matters dealt with in a recent issue of the *Journal of the Board of Greenkeeping Research* (7, No. 24 ; 1948) are papers on the consolidation of lawn surfaces by bitumen, and a useful review of methods of earthworm control on lawns. R. B. Dawson and J. R. Escritt describe the method of stabilizing the surface of lawns by the application of sand and bitumen emulsion immediately after the grass seeds are sown. The treatment can also be applied to established turf. Lawn surfaces were much improved, and the process may be useful for small areas subject to heavy wear. Detrimental effects were not very marked, but the establishment of bent and timothy grasses was reduced. J. R. Escritt and J. H. Arthur review the methods available for earthworm control. Many species of earthworm do not form casts, and therefore are not a nuisance, but only help in aeration and soil mixing. Organic manures generally stimulate earthworm activity, while the presence of a turf 'mat' diminishes the production of unsightly casts. Factors of management and manuring are therefore important. The relative merits of mowrah meal, copper sulphate, potassium permanganate, derris, mercuric chloride, lead arsenate and other control substances are discussed and provide a very useful advisory review of this matter.

Sugar Beet Viruses

THE virus of sugar beet yellows has not hitherto been regarded as seed-borne. Phyllis E. M. Clinch and J. B. Loughnane have shown, however (*Sc. Proc. Dub. Soc.*, 24, No. 27 ; July 29, 1948), that seed of a new family of sugar beet (No. 41), when germinated, gives a considerable percentage of yellowed seedlings. The identity of this yellowing with sugar beet yellows is somewhat by implication ; but the symptoms and physiological effects are similar. The paper also describes two types of yellows disease from commercial sugar beet crops in Eire. Sugar beet yellows is probably the most serious disease of this crop in England. R. Hull and Marion Watson have a useful paper in the *Journal of Agricultural Science* (37, Part 4, 301–310 ; 1948) on the relation of nutrition and variety with severity of yellows. Manurial treatments in general increase the yields of roots and sugar ; but the losses caused by infection unfortunately increase proportionately as the mean yields increase. Fertilizers have little effect in varying the symptoms of the disease. Commercial varieties and some breeders' lines were tested for possible tolerance of the virus ; but no useful indication of this was obtained.

Norwegian Strandflat

IN a paper in the *Geographical Journal* of January on the "Geomorphology of Norway", Prof. K. M. Ström returns to the topic of the strandflat, a topic which has evoked much controversy in past years. He believes that marine abrasion is much in evidence, though corrie glacier abrasion has played its part. The low plain cuts across fjord deeps and corrie lake deeps, and though local glaciers have certainly played a notable part, it is in the main due to marine abrasion. Prof. Ström cites the example of Moskenesöy, which has practically no strandflat on the inner or sheltered side, but has an abrasion platform 8 km. broad on the exposed side. The tendency to stress glacial action in the formation of the strandflat is probably due to the study of the strandflat where it shows a hummocky appearance through an overflow by ice during the last glaciation. The main features of the strandflat seem to have been abraded at successively lower levels since early Miocene times up to late Pliocene ; this has been followed by excavation by glaciers from the inland ice and corrie glacier erosion and, finally, post-glacial marine abrasion in the peripheral areas where changes of level due to isostatic recovery have been least.

Earthquakes during January

FOURTEEN strong earthquakes occurred in various parts of the world during January. The strongest were those on January 23, 24 and 27, with epicentres in the Indian Ocean (about 600 miles south-west of Sumatra), near the Tonga Islands, and in New Britain respectively. Three earthquakes had deeper foci than is normal ; two, having a depth of about 100 km., occurred on January 23 and 24, and the third, depth 600 km., on January 13 with an epicentre south of the Fiji Islands. It may be noted that no earthquake is so far known to have had its focus at a greater depth than 700 km. All the earthquakes during the month occurred in well-known seismic areas, though the one on January 28 in the Atlantic Ocean some 1,100 miles east of Bermuda is not in an area from which earthquakes often occur. Observatory records have been received from the central stations of the United States Coast and Geodetic Survey and from Strasbourg, and from individual observatories at Beograd (Jugoslavia), De Bilt (Holland), Durham, Kew, Strasbourg, Stuttgart and Toledo (Spain).

Mekran (Baluchistan) Earthquake of November 28, 1945

C. G. PENDSE has discussed all available data for the earthquake at Mekran in Baluchistan on November 28, 1945 (*Ind. Met. Dept., Sci. Not.*, 10, No. 125 ; 1948). The epicentre was in the sea off the Mekran coast, and strength 10 on the Rossi–Forel scale was attained in the epicentral area. The instrumental magnitude was about 6·7, and the energy was of the order of 10^{21} ergs. The earthquake was attended by a seismic sea-wave which affected the whole of the Arabian seaboard. At Karwar, about 1,000 miles from the epicentre, the wave flooded the creeks and inlets, and boats anchored in the harbour were cut off from their moorings. There was serious loss of life and property at Pasni, the height of the second wave there being estimated at between 40 and 50 ft. At Karachi four distinct waves were distinguishable, and at Bombay a seismic sea-wave 6½ ft. high was experienced. It has been reported that two rocky oval islets, about three miles apart, appeared about the same time as the earthquake, some 180 miles west-south-west of Karachi. One islet rose about 30 ft. above the water and the other about 100 ft., the former having an area of about 1½ square miles and the latter about a square mile. Earthquakes have occurred in the past in the area off the Mekran coast on February 4, 1938, and January 7, 1940. Earthquakes on land near the point occurred on September 2, 1938, October 29, 1941, July 3, 1942, July 4, 1942, and February 6, 1943. Very strong earthquakes have occurred in the past at Chaman (Baluchistan) on December 20, 1892; at Kachhi (Baluchistan) on October 21, 1909; at Mach (Baluchistan) on August 27, 1931; as well as at Cutch on June 16, 1819, and at Quetta on May 31, 1935.

Southwest Research Institute, Texas

THE Southwest Research Institute, San Antonio, Texas, has approved of the establishment of a division of oceanography and meteorology and a division of petroleum technology in Houston, Texas. The division of oceanography and meteorology will be of particular scientific importance, since oceanographic data on the Gulf of Mexico are particularly scanty. The research in this field will commence with a survey of currents, the shifting topography of the shelf area, and marine life in the Corpus Christi area, and the work will then be extended eastwards. The schooner *Harpoon* has already been earmarked for research in the Gulf. The oceanographic work will be in two phases: first, the project of the Institute, which will be freely published; and second, the fulfilment of private contracts, which will be paid for by the firms concerned on a cost basis. The establishment of the division of petroleum technology in Houston is the result of the widespread activity with regard to petroleum in that area and the fact that the local industries have immediate problems which can well be undertaken by the Southwest Research Institute. The Institute itself is a non-profit, endowed research organisation.

Unesco Fellowship Handbook

THE secretariat of Unesco has prepared a most useful handbook providing details of all available opportunities for trans-national study and organised arrangements made in this field, which should be of real assistance to those wishing to travel out of their own countries for purposes of study. The handbook, which is intended to be the first of a series, constitutes a repository of information on the considerable investments by governments, universities, foundations and charitable institutions in the promotion of international study. Whether these fellowships or awards are designed to assist the reconstruction or development of a particular country, to encourage scientific research, to stimulate artistic exchange or to promote international understanding in general, they represent a striking volume of assistance from many sources to individuals chosen for their capacity to advance the course of learning and to profit from the cultural heritage of countries other than their own. Copies of the handbook, which may be obtained from H.M. Stationery Office, price 5*s*., show that more than ten thousand opportunities for international study are available for the year 1948–49.

Gamma-Emitting Materials for Industry

THE Ministry of Supply has recently announced that radium and radon can now be supplied for use in industrial radiography. Radium is available on hire only, and will remain the property of the Government. It can be hired for periods of not less than six months, and the average time to fulfil an order is two months. Radon is sold outright, and notice of one week is required for an order. Demonstrations of gamma-radiography for industrialists can be seen by appointment at the Ministry's Armament Research Establishment, Woolwich, London, and at the National Physical Laboratory, Teddington, Middlesex. Radium and radon are supplied by the Radiochemical Centre, Amersham, Bucks, and applications for purchase or loan should be addressed to that establishment.

Spectrographic Research Unit of the Medical Research Council

BY arrangement with the London Hospital, the Medical Research Council has established there a Spectrographic Research Unit under the direction of Dr. E. R. Holiday. The primary function of the Unit is to undertake original research work in the field of absorption spectrophotometry as applied to biological problems of medical interest; but advice and assistance will also be given to other branches of the Council's organisation using such methods. The Unit has been based on the spectrographic department originally established by the London Hospital, and during the last five years partly supported by the Council for the purposes which are now being developed.

Education of the Young Worker

A SECOND Conference on the Education of the Young Worker, with a special subject for consideration, "The Entry into Work, Guidance and Initiation", will be held at Manchester College, Oxford, during July 23–29, 1949. Like its predecessor in 1948, it has been arranged under the auspices of the University Department of Education, the director of which is Mr. M. L. Jacks, and aims at bringing together representatives from industry, education, central and local government departments, voluntary organisations and other bodies which are concerned in the education and welfare of young people between the ages of fifteen and twenty who are no longer in full-time education. The Conference will work in commissions; but whereas last year each commission had a special subject to consider, this year the subjects will be the same for all commissions, each of which will report its findings to the whole Conference at plenary sessions. Further information can be obtained from the Director, University Department of Education, 15 Norham Gardens, Oxford.

British Social Hygiene Council: Summer School in Austria

OWING to various difficulties connected with foreign travel, the Summer School on "The Family and the Nation", which the British Social Hygiene Council had arranged to hold at the University, Berne, Switzerland, during August 17–September 1, has now been transferred to Pertisau in the Austrian Tyrol. There will be no change in the lecture programme, which will deal with different aspects of family life, such as marriage problems, nutrition, human heredity, population, the welfare of old people, the problem family, and juvenile delinquency. As in the past, only the first week will be devoted to study, the second week being entirely free for rest and recreation and for excursions to places of beauty and interest in the surrounding countryside. The cost, including travel, hotel accommodation and tuition, will be approximately £34. Further information can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Royal Institution

AT the anniversary meeting of the members of the Royal Institution held on May 2, the following officers were elected: *President:* Lord Brabazon of Tara; *Secretary:* Prof. A. O. Rankine; *Treasurer:* Dr. R. E. Slade; *Managers:* Prof. D. Brunt, Major W. H. Cadman, Sir John Craig, Mr. E. R. Davies, Dr. C. H. Desch, Prof. H. Dingle, Dr. P. Dunsheath, Prof. G. I. Finch, Prof. F. L. Hopwood, Dr. E. T. Paris, Prof. H. J. Plenderleith, Sir Harry Railing, Prof. H. R. Robinson, Prof. A. M. Tyndall, Mr. F. Wakeham; *Visitors:* Colonel S. J. M. Auld, Dr. H. E. Cox, Dr. H. J. T. Ellingham, Dr. R. E. Gibbs, Prof. H. Heywood, Mr. A. J. Hughes, Dr. L. H. Lampitt, Mr. R. Le Rossignol, Mr. A. Marshall, Dr. D. C. Martin, Dr. A. C. G. Menzies, Mr. J. W. Ryde, Mr. F. M. Saxelby, Dr. H. Shaw, Dr. O. H. Wansbrough-Jones.

Capper Pass Awards for Metallurgy

THE Capper Pass Awards for 1948, which are recommended by a committee on behalf of the Institution of Mining and Metallurgy and of the Institute of Metals, have been won by the following: Messrs. C. Blazey, L. Broad, W. S. Gummer and D. P. Thompson (Metal Manufacturers, Ltd., Port Kembla, New South Wales, Australia) £50 jointly, for a paper on "The Flow of Metal in Tube Extrusion"; Mr. H. R. Potts (Minas de Rio Tinto) £50, for a paper on "Further Notes on Converter Practice at Rio Tinto"; Messrs. R. C. Trumbull (Pyrites Co., Inc.), W. Hardiek (Pyrites Co., Inc.) and E. G. Lawford (Rio Tinto Co., Ltd.) £50 jointly, for a paper on "Notes on the Treatment of Pyrites Cinders at the Plant of the Pyrites Co., Inc., Wilmington, Delaware". The money for these awards has been given by Messrs. Capper Pass and Son, Ltd., Bristol, and is allotted as follows: £100 each year for one or more awards to authors of papers on some aspect of non-ferrous extraction metallurgy submitted to the Institution of Mining and Metallurgy; and £100 each year for one or more awards to authors of papers submitted to the Institute of Metals and relating to some process or plant used in the fabrication of non-ferrous metals, contributed by persons engaged full-time in industrial practice. All papers relating to these fields and published in 1949 by either of the two Societies will be considered for awards; authors need not be members of either Society and may be resident in any country. Manuscripts should preferably be submitted in duplicate to either the Secretary, Institution of Mining and Metallurgy, Salisbury House, Finsbury Circus, London, E.C.2, or the Secretary, Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, from whom further particulars may be obtained.

Royal Aeronautical Society: Awards

THE Royal Aeronautical Society has announced the award of the following medals and prizes: *British Gold Medal*, for practical achievement in aeronautics, to Mr. S. Camm, director and chief designer, Hawker Aircraft, Ltd., for his outstanding work in the design and development of fighter aircraft; *British Silver Medal*, for practical achievement in aeronautics, to Lieut.-Commander E. M. Brown, for his outstanding achievements in advancing the technique of deck landing; *Royal Aeronautical Society's Bronze Medal* to Capt. R. N. Liptrot, for his work on helicopters; *Wakefield Gold Medal* to Mr. E. S. Calvert, for his work in the development of airport lighting; *George Taylor (of Australia) Gold Medal* to Mr. G. R. Edwards, chief designer, Vickers Armstrongs, Ltd., Weybridge Works, for his paper on "Problems in the Development of a New Aeroplane"; *Edward Busk Memorial Prize* to Mr. W. Stewart, for his paper on the "Flight Testing of Helicopters"; *Herbert Ackroyd Stuart Memorial Prize* to Mr. W. H. Lindsey, for his paper on "Development of the Armstrong Siddeley Mamba Engine"; *Usborne Prize* to Mr. D. R. Maguire, for his paper on "Enemy Jet History"; *R. P. Alston Memorial Prize* to Mr. B. A. G. Mcgowan, for his work in the flight testing of gliders; *Baden-Powell Memorial Prize* to Mr. R. J. Starling, for being the best entrant in the associate fellowship examination.

Announcements

DR. JOHN RAMSBOTTOM, keeper of botany in the British Museum (Natural History), has been awarded a Grande Médaille Isidore Geoffroy Sainte-Hilaire by the Société d'Acclimatation et de Protection de la Nature.

THE Institute of Metals has appointed the following to be honorary corresponding members for their respective countries: *Belgium*, Henri Féron, administrative director, Visseries et Tréfileries Réunis S.A., Haren; *Holland*, Max Hamburger, director, Royal Nederlandsche Lood- en Zinkpletterijen voorheen A.D. Hamburger, Utrecht; *Italy*, Dr. Leno Matteoli, vice-director, Istituto Scientifico Tecnico Ernesto Breda, Sesto S. Giovanni, Milan.

THE Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, has published as a booklet of sixty pages Appendix III from the "Universities Yearbook" of 1948. This Appendix consists of a list of postgraduate scholarships and grants for advanced study and research tenable at the universities of Great Britain and Ireland during 1948–49, and though the awards for 1949 have for the most part been already made, yet most of the information will be applicable to next year. The classification of contents is by subjects.

THE Italian review *Ulisse* is offering a prize of one million lire (about £450) for the best work of popular science in the fields of physics or chemistry which has been published in the last five years. The prize is open to books published in Italian, French, English, Spanish and German, and three copies of each book entered for the prize should be sent to *Revista Ulisse* (Sezione Premio Europeo Cortina), Corso d'Italia 43, Rome, before June 15. If the winning work is by a non-Italian author, it is hoped to arrange for the book to be translated into Italian and published in Italy.

REFERENCE was made in *Nature* of April 23, p. 618, to the setting up, by the Parliamentary and Scientific Committee, of a sub-committee to investigate the question of payment for scientific and medical teaching staffs at the universities. We are informed that in view of the new circumstances it has been decided not to proceed with this matter.

ERRATUM.—In the announcement in *Nature* of April 23, p. 634, relating to the Busk aeronautical studentship, it should have been indicated that, subject to the permission of the trustees, the student may carry out his research in Great Britain or abroad.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radioactive Phosphorus in Biochemical Research

It is generally required in radioactive tracer procedure when applied to biochemical problems that the stable and radioactive molecules or ions possess identical configurations. Only when the two isotopic atoms are supplied in the same chemical form can it be assumed that living tissues will absorb them in the proportions applied. In experiments carried out here with phosphorus-32, it was found that this requirement was not satisfied, and since no information is available on the selectivity of the plants to isotopic elements in different chemical forms, our data cannot be interpreted.

A sample of radioactive disodium hydrogen phosphate with a phosphorus-32 activity of 0·1 millicurie, prepared by slow neutron bombardment of $Na_2HP^{31}O_4$ at the Atomic Energy Research Establishment, Harwell, was used. The irradiated salt was applied in aqueous solution to the roots of growing plants. At the end of the investigation, check experiments indicated that less than 50 per cent of the phosphorus-32 was present as orthophosphate. In other words, half the total phosphorus-32 was present in a different chemical form, or forms, from that of the main bulk of $Na_2HP^{31}O_4$. The analytical procedure used to establish the above fact was as follows: the orthophosphate was precipitated as magnesium ammonium phosphate, ignited to magnesium pyrophosphate, weighed to give 'total' phosphorus, and assayed for phosphorus-32 with a Geiger counter. This precipitate gave less than half the number of counts per minute given by the same volume of original radioactive solution evaporated to dryness in a counting dish. Only rigorous oxidation of the radioactive solution with concentrated nitric acid and 60 per cent perchloric acid prior to precipitation ensured the oxidation of all the phosphorus-32 to orthophosphate, and resulted in a pyrophosphate count comparable with that given by the evaporated aliquot.

Our attention was directed by the Atomic Energy Research Establishment to the work of Libby[1] in which effects of slow neutron bombardment on some inorganic compounds, including those of phosphorus, had been investigated. Libby confirmed that any molecule containing an atom absorbing a neutron would probably be decomposed by the initial recoil of the nucleus, resulting from the emission of the gamma quantum ($P^{31}_{15} + n^1_0 = P^{32} + \gamma$), in a general Szilard–Chalmers type of reaction[2]. In the case of orthophosphates, he suggested that this disruption would result in the ejection of oxygen, presumably the fragment containing the phosphorus-32 being in the form of a phosphite. By some process, however, which seemed to operate during irradiation, Libby found that in the final product about 50 per cent of the phosphorus-32 consisted of regenerated $Na_2HP^{32}O_4$ molecules.

In view of the increasing interest in the application of radioactive tracers to biochemical problems, it is desirable that prospective users of phosphorus-32 should be aware of the severe degradation of sodium orthophosphate which occurs during neutron irradiation in the atomic pile. If a material of a definite chemical form is required, it is essential to use phosphorus-32 prepared by pile irradiation of sulphur-32, and even then the identity of the active material should be confirmed before it is used.

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[1] *J. Amer. Chem. Soc.*, 62, 1930 (1940).

[2] *Nature*, 134, 462 (1934).

Effect of Enzyme Inhibitors on the Genesis of Phage

It is generally agreed that the multiplication of viruses is intimately linked with the metabolism of the host cell[1]. It seemed, therefore, interesting to study the influence of enzyme inhibitors on the development of virus within the host cell. In this connexion we have launched an extensive investigation with regard to the influence of enzyme inhibitors on the growth of the bacterial cell and the development of 'bacterial virus' particles respectively.

For our first experiments we have used a coli-phage system. Tryptose medium cultures of *Escherichia coli*, strain *B*, were infected with suspension of T_2 phage. The following procedure was adopted: after two and a half hours growth the *E. coli* culture was split up into equal parts, which were treated with various inhibitors for one hour. The number of lytic particles used was calculated so as to assure infection of each bacterium by no more than a single phage particle, and plating out was done after 20 minutes incubation. Some details of the method used have already been reported[2].

Some of the substances examined had no effect on host cell or phage (sodium malonate, sodium fluoride 1/5,000–1/10,000); a second group inhibited both elements in the experimental system (penicillin, acriflavine, mapharside, malonic acid in higher con-

Inhibitor	Concentration (m*M*.)	Number of lytic particles (percentage of original inoculum)
Control		2,000–10,000
Hydroquinone	30	58
	15	78
	7·5	84·1
	50	61·9
	5	86
4-6-Dimethoxy-toluquinone	5·5	99·3
	0·55	124
Tetramethyl-*p*-phenylene diamine	3	83·4
	0·3	85·3
Malonic acid	100	0·27
	20	94·8
	10	81·7
	10	63·2
	5	142
Iodoacetic acid	25	44·6
	5	62
	1	78·6
Auramine	0·66	108
	0·066	72·3
Sodium cyanide	50	11·4
	10	60·5
	5	84·4
Sodium fluoride	24	114
Calcium chloride	10	160
Urethane	300	77·4
Colchicine	0·008	115
	0·004	180
	0·0004	159

centrations); and a third group checked multiplication of phage, but had no obvious influence on the reproduction of *E. coli*, as was shown by controls (hydroquinone, 4-6-dimethoxy-toluquinone, tetramethyl-*p*-phenylene diamine, malonic acid, iodoacetic acid, auramine, sodium cyanide, sodium fluoride, calcium chloride, urethane, colchicine).

The influence of different concentrations of the substances belonging to this third group upon the multiplication of phage is summarized in the accompanying table.

The substances under consideration belong to different chemical groups, and their range of enzymatic inhibition is varied; but all seem to share one property, namely, that of interfering with succinic dehydrogenase. The influence of succinic dehydrogenase on the multiplication of viruses awaits explanation.

Suppression of the multiplication of phage is shown clearly by the figures in the table; but it seems to be merely temporary, since preliminary experiments with hydroquinone indicate the probability of phage increase at later stages.

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[1] Foster, C., Jones, J. H., Henlé, W., and Dorfman, W., *J. Exp. Med.*, **79**, 221 (1944). Friedewald, W. F., *J. Exp. Med.*, **75**, 197 (1942). Parker, R. F., and Thompson, R. L., *J. Exp. Med.*, **75**, 567 (1942). Rasmussen, jun., A. F., Waisman, H. A., Elvehjem, C. A., and Clark, P. F., *J. Infect. Dis.*, **74**, 41 (1944). Sprunt, D. H., *J. Exp. Med.*, **75**, 297 (1942). Toomey, J. A., Frohring, W. O., and Takacs, W. S., *Yale J. Biol. Med.*, **16**, 477 (1944).

[2] Dolby, D. E., and Czekalowski, J. W., *Nature* [**163**, 608 (1949)].

Difference between Morphine and Synthetic Analgesics in their Actions on Ganglionic Transmission

THE analgesic actions of certain new synthetic compounds, including pethidine and amidone, have been extensively compared with that of morphine[1]. It is assumed that this analgesic action is mainly due to a central effect, although the possible local anæsthetic properties of these compounds have not been investigated.

Pethidine and amidone, in common with morphine, inhibit both pseudo- and true cholinesterases[2]. There is no evidence to show that their anticholinesterase activity is related to their analgesic properties. But in view of the importance of acetylcholine in the mediation of impulses over autonomic pathways, it is of interest to determine how transmission through autonomic ganglia may be influenced by these drugs.

A structure in which such transmission can conveniently be examined is the cat's superior cervical ganglion perfused according to Kibjakow[3]. In our experiments, we studied the effects of morphine sulphate, pethidine hydrochloride, *l*- and *d-l*-amidone hydrochloride on normal and denervated ganglia, using the nictitating membrane as the indicator of transmitted nerve impulses.

None of these drugs when injected into the ganglion was able to excite a contraction of the muscle; but pethidine and amidone (*l*- and *d-l*-forms) depressed or abolished responses of the nictitating membrane to (1) electrical stimulation of the preganglionic nerve fibres, (2) injection of acetylcholine, and (3) injection of potassium chloride. The depressant effect of each drug was maximal $\frac{1}{2}$–1 min. after injection; with small doses it wore off after 3–20 min.; while with larger doses it might be irreversible. In the case of pethidine, the effective dosage was 10–100 μgm., for *d-l*-amidone it was 5–50 μgm. and for *l*-amidone 1–10 μgm. Thus *l*-amidone was about twice as active as *d-l*-amidone and ten times as active as pethidine. Analogous results were obtained on denervated ganglia when acetylcholine or potassium chloride was used as stimulus.

The action of morphine is entirely dissimilar. In the normal ganglion, even doses so large as 2 mgm. do not alter the response to the above-mentioned stimuli; but in the denervated ganglion, doses of 100 μgm. and upwards have a very marked potentiating action for both acetylcholine and potassium chloride. In the increase of the size of contraction of the muscle, the effect was comparable to that obtained with eserine sulphate (2 μgm.), although it did not last so long.

In further experiments on anæsthetized cats, we have tested the effect of intravenous and intracarotid injections of *l*-amidone; we find that to depress the nictitating membrane response to preganglionic stimulation, the doses then required are 50–100 times greater than those used in the experiments on perfused ganglia. Since the addition of amidone to the general circulation does not diminish the nictitating membrane response to intravenous adrenaline, it seems probable that its depressant effect under both conditions of experiment is due to an action on ganglionic transmission.

In addition, tests carried out on the isolated frog rectus abdominis muscle have shown that its responses to acetylcholine are characteristically modified by pethidine, amidone and morphine: pethidine (minimal concentration 0·0001 M) and *l*-amidone (minimal concentration 0·00001 M) are depressant, whereas morphine (minimal concentration 0·001 M) produces a potentiation.

Concerning these observations, the following comments may be made.

(1) It would appear that the effect, if any, of the anticholinesterase activity on transmission in the autonomic nervous system of pethidine and amidone is overshadowed by their predominantly depressant action. In this connexion, it may be noted that pethidine (5–10 mgm./kgm. intravenously) decreases the irritability of the vagus nerve of the dog[4].

(2) In view of their depressant effects on synaptic transmission, an action which may not be confined to the autonomic nervous system, pethidine and amidone appear to be potentially more dangerous than morphine, which does not share this property.

(3) The quantitative differences between the activities of pethidine, *d-l*-amidone and *l*-amidone in depressing ganglionic transmission correspond approximately with the differences in their effectiveness as analgesic agents. In both cases pethidine is the least powerful, whereas *l*-amidone is the most powerful, and *d-l*-amidone is intermediate between the other two.

(4) The analogous behaviour of the frog rectus muscle and of the superior cervical ganglion in their susceptibility to the depressant effects of pethidine and amidone, and to the potentiating action of

morphine, is a further indication that the ganglion cell with its axon has many properties in common with the motor end-plate and its muscle fibre.

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Sympathin

MANY workers are now engaged in studies on the substance or substances liberated at the nerve endings when sympathetic nerve fibres are stimulated. In some cases, it has been shown to be adrenaline, whereas in others results indicate that it may be *nor*adrenaline. Recently, Bülbring and Burn[1] showed that even splanchnic nerve stimulation (after evisceration and ligation of the renal vessels in spinal cats) can result in the liberation of varying proportions of *lævo-nor*-adrenaline with the adrenaline.

In cats under chloralose and cocaine, after double vagotomy, we have been able to show that in at least two cases the nature of sympathin (as shown by effects produced in distant parts of the animal) depends upon the length of time the nerve has been sectioned before being stimulated. Stimulation of the hepatic nerve immediately after sectioning, for example, produced contraction of the denervated nictitating membrane, relaxation of the non-pregnant uterus and a rise of blood pressure, effects well equated by slow intraportal infusions of equi-pressor doses of adrenaline (not *nor*adrenaline). Two hours or more later, stimulation produced contraction of the nictitating membrane and a smaller rise of blood pressure but no action on the uterus, effects well equated by slow intraportal infusions of equi-pressor doses of *nor*adrenaline (not adrenaline). A very small stimulus to the splanchnic nerve applied immediately after, and several hours after, sectioning produced similar results, although the matching was carried out, in this case, by slow intravenous infusions of equi-pressor doses of adrenaline or *nor*-adrenaline. Hypogastric nerve stimulation did not, however, give corresponding results, for the sympathin effects as recorded by relaxation of the non-pregnant uterus were always equated by slow intra-arterial infusions of adrenaline.

After dibenamine (15 mgm./kgm.), stimulation of the hepatic nerve immediately following sectioning produced slight relaxation of the non-pregnant uterus, and a fall of blood pressure preceded by a small rise. The rise could be produced by sham stimulation and was probably due to constriction of the hepatic artery. The fall was well equated by slow intraportal infusions of adrenaline. Later, stimulation produced no effect on the uterus, and a rise of blood pressure only, corresponding to the action of slow intraportal infusions of *nor*adrenaline. Similar effects, however, could not be produced by normal adrenaline-reversal doses of ergotoxine.

It appears, therefore, that sectioning of some sympathetic nerves may be linked with the inhibition of methylation of the primary amine, so that stimulation produces more *nor*adrenaline and less adrenaline. In these cases, the normal adrenergic mediator may be a mixture of varying proportions of adrenaline and *nor*adrenaline.

It is hoped to analyse the blood at various stages and so identify the substance or substances liberated.

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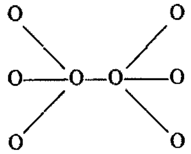
Phloroglucitol Diammoniacate, $C_6H_9(OH)_3.2NH_3$

THE determination of the crystal structure of phloroglucitol dihydrate, besides establishing the fact that the α-phloroglucitol molecule has the configuration κ,κ,κ, shows that the water molecules are chiefly responsible for the cohesion of the organic molecules in the lattice[1]. The structure is rhombohedral, and in the (111) planes equilateral triangles of hydroxylic oxygens are formed, each of the three oxygen atoms belonging to a separate phloroglucitol molecule. On the line perpendicular to the plane of the triangles and joining the centres of two triangles, *two* water molecules are situated; and the distance from each water oxygen to the nearest three alcoholic oxygens and also the distance between the two water oxygen atoms is about 2·75 A. It is obvious, therefore, that the bonds linking together the



group are hydrogen bonds.

We thought it possible that a structure based on this arrangement might be preserved, at least at low temperatures, when the two water molecules are replaced by molecules of ammonia. Anhydrous phloroglucitol was therefore dissolved in liquid ammonia free from traces of water, and the ammonia allowed to evaporate slowly. The crystals formed in this way showed a development very similar to that of the dihydrate. They are quite stable when kept in a closed vessel at 0° C., but at room temperature and in the open air the ammonia escapes, leaving a powder of anhydrous α-phloroglucitol.

Taking special precautions it was possible, however, to obtain X-ray photographs of single crystals and to ascertain that the crystal structure corresponds to that of the dihydrate mentioned above. The lattice dimensions are, however, a little greater than those of the dihydrate. This is just what would be expected, because both the O—H—N and N—H—N bond distances must be somewhat larger than the corresponding O—H—O distances. The intensities of corresponding X-ray reflexions, although not identical, are very similar.

It seems reasonable to believe that the possibility of replacing water by ammonia is not limited to the hydrate of the trivalent alcohol in question, and it seems even possible that other substances than ammonia capable of forming hydrogen bonds may build up structures corresponding to those of the hydrates. Further studies in this direction, now in preparation, may give valuable information concerning the properties of hydrogen bonds. Full details concerning the structure of the phloroglucitol diammoniacate will be published in *Acta Chemica Scandinavica*.

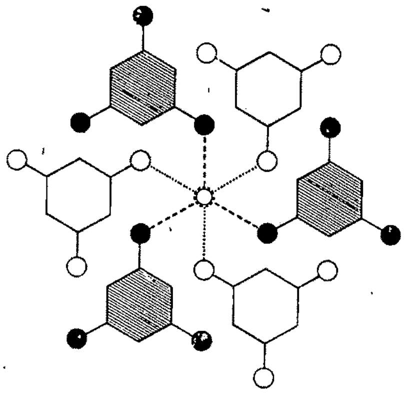


Fig. 1. Part of the $C_6H_9(OH)_3.2NH_3$ structure projected along the trigonal axis

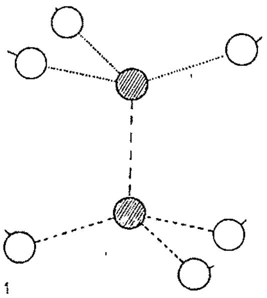


Fig. 2. The O_3—N—N—O_3 arrangement

In Fig. 1 part of the structure projected along the trigonal axis is reproduced; Fig. 2 shows the arrangement of the O_3—N—N—O_3 group.

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Structure of Polyglycine

In a preliminary report on a chemical, X-ray and infra-red investigation of synthetic polypeptides[1], one of the forms of polyglycine was tentatively assigned a rectangular unit cell of dimensions: $a = 4\cdot36$ A. (or twice that), $b \approx 7$ A., and $c = 3\cdot44$ A. I should like now to correct this in the light of more recent considerations.

At a meeting in November 1948 of the X-Ray Analysis Group of the Institute of Physics, it was suggested by Bunn that polypeptides with shorter side-chains, and polyglycine in particular, might be expected to fit together in approximate close-packed arrangements like that found in the polyamides (nylons)[2], in which, though the interplane *spacing* is $4\cdot36_5$ A., the actual distance between chains bridged by CO . . . NH hydrogen bonds is 4·77 A. Rudall, working in this laboratory, and reviewing in another connexion the types of packing in protein structures, has also lately directed my attention to the improbably high density (about 1·8 gm./c.c.) that would be required if polyglycine had the rectangular cell proposed. We had no density data at the time; but the density of a preparation of polyglycine film has now been measured[3] and found to be close to 1·51 gm./c.c.

Taking Bunn's scheme and the same hydrogen-bonded distance between chains as in nylon, together with the residue-length (3·67 A.) estimated by Corey[4] for a completely extended polypeptide, the calculated density of polyglycine is

$$\frac{57 \times 1\cdot65}{4\cdot77 \times 3\cdot44 \times 3\cdot67} = 1\cdot56 \text{ gm./c.c.},$$

in satisfactory agreement with experiment. On this basis the β-angle is $\sin^{-1} 4\cdot36/4\cdot77 = 66°$; also, of course, practically the same as the corresponding angle in nylon.

The special importance of this result is in relation to the infra-red data[1], which show that in spite of substantial variations in backbone spacing, the CO . . . NH linkage remains virtually unchanged. Bunn's interpretation would be to keep a fairly constant inter-chain backbone distance (round about 4·77 A.) and let the β-angle increase with increasing side-chain distance until in β-keratin, for example, where the backbone spacing is 4·65 A., the cell becomes approximately rectangular (as direct observation shows[5]); and there seems little doubt now that this view is sound as regards polyglycine at least. Whether it is generally valid for polypeptides with longer side-chains—and there are evident difficulties at the moment—must await the results of calculations from density data not yet available.

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Refining of Oils Containing Vitamin A

THE alkali-refining of fish liver oils containing vitamin A has, in the last few years, acquired increased importance due to the development of molecular distillation. This method of distilling, while yielding concentrates of a high vitamin A content, requires, in order to obtain satisfactory results, oils free from impurities and with low acid-values. Alkali-refining provides the best means of satisfying this requirement; but it has been considered that a treatment of this kind decreases the potency of vitaminic oils because of the adsorption of vitamin A by soaps formed *in situ*[1].

Experiments carried out in this Laboratory with a number of fish liver oils seem to indicate that under normal refining conditions just the opposite is the case. The neutralized oil, far from losing anything of its original potency, extracts to a large extent vitamin A from the soap formed during the neutralization, so that the result of the alkali-treatment is increased, and not diminished, potency. In oils with high potency and high acid-value, this increase can be quite substantial, as illustrated by the following example.

A sample of Groper liver oil with 120,000 I.U. of vitamin A per gm., 12·5 per cent free fatty acids and 3·95 per cent impurities[2] was neutralized with an excess of sodium carbonate, centrifuged and filtered. The results are shown below:

	Weight (gm.)	Vitamin A potency (I.U. per gm.)	Total content of vitamin A (I.U.)
Original oil	24·50	120,000	2,940,000
Neutralized oil	18·75	140,000	2,625,000
Oil in soapstock	5·75 (by difference)	44,000	253,000

The 5·75 gm. of soapstock oil consisted, according to the analysis, of 3·06 gm. fatty acids, 0·97 gm. impurities and 1·72 gm. neutral oil, which latter could be extracted with petrol ether from the soapstock. The potency of this oil can be assumed as 140,000 I.U. per gm., the same as the bulk of the neutralized oil, and consequently 1·72 gm. of it accounts for 240,800 I.U. out of the total of 253,000 I.U. in the soapstock. This leaves for the fatty acids in the form of soap, and for the impurities, 12,200 I.U., or less than 0·5 per cent of the total amount of vitamin A present in the original sample.

The loss of vitamin A during the alkali-refining is, therefore, due mainly to some neutral oil being carried away with the soapstock, while the potency of the neutralized oil has increased. As the latest refining methods allow of a loss closely approaching the theoretical Wesson loss, the amount of trapped neutral oil being reduced to a minimum, it seems now beyond doubt that alkali-refining provides the most economical and simple method of purifying oils containing vitamin A.

It may be added that the alkali-refining of vitaminic oils prior to molecular distillation is covered by a patent[3]. In the example contained in this patent, there is an indication of increased potency of neutralized oils, inasmuch as 4,600 gm. of pollack liver oil having a vitamin A potency of 10,600 units per gm. (or a total of 48,760,000 units) has yielded 4,285 gm. of refined oil with a vitamin A potency of 12,200 units per gm. (or a total of 52,277,000 units). This increase, however, shown without any explanation, amounts to a net gain of 3,517,000 units of vitamin A produced out of nothing, and, therefore, must be attributed to an experimental error.

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Explosive Decomposition of Ethylene Oxide

THE slow decomposition of ethylene oxide vapour has received the attention of a number of investigators[1-3]. In extension of their work, we have studied the limiting conditions of temperature and pressure under which the reaction becomes explosive in a 550 c.c. quartz bulb.

At 773° K., the presence of nitrogen very slightly raises the minimum ignition pressure, as the following figures show:

Moles N_2 added per mole C_2H_4O	Pressure (partial) C_2H_4O at limit (mm.)
0	90
0·5	91
1·0	93

This result suggests that the ignition is of a thermal character and that, in accordance with the weight of opinion regarding the slow decomposition, the reactions leading to ignition do not involve chains. For such a thermal ignition the pressure (p) and temperature (T) at the ignition limit are related, theoretically, by $\log_{10} p/T = A/T + B$, where A and B are functions of the thermal properties of the system and the kinetics of the reaction leading to ignition.

We have traced the p–T explosion limit of ethylene oxide from 90 mm. at 773° K. to 325 mm. at 743° K., and find that between these points the graph of $\log p/T$ against $1/T$ indicates a continual decrease of A and/or B with rising temperature. The most probable explanation is that B is decreasing, thus implying an increase in the order of reaction with increasing temperature, that is, with decreasing pressure. This conclusion is in accordance with the findings of Thompson and Meissner[2] with regard to the slow decomposition reaction in the same pressure-range.

Our detailed conclusions on this subject, together with those relating to the flame reactions of ethylene oxide in the presence of oxygen[4], will be published in due course.

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Stability of Chelate Complexes

ATTENTION has recently been directed to parallelisms in the order of the stability constants of the complexes formed by bivalent metal ions with different ligands[1,2]. We have investigated the stability constants of the complexes formed by metal ions with β,β′,β″-triaminotriethylamine, $N(CH_2CH_2NH_2)_3$, (tren), which can provide four ligand atoms for a given ion, as previously shown by Mann and Pope[3], who prepared complexes of this tetramine with several bivalent ions. The stability constants have been evaluated by combining the acidity constants of the acid $(trenH_3)^{3+}$ with the equilibrium constants of the reaction:

$$M^{2+} + (\text{trenH}_3)^{3+} \rightleftharpoons M(\text{tren})^{2+} + 3\text{H}^+.$$

Measurements were made at 20° C. with a hydrogen or glass electrode at an ionic strength of 0·1 (usually a 0·1 *M* solution of potassium chloride was used and a correction for chloro-complex formation applied where necessary). Except in the cases of silver and mercury, and to a much lesser extent nickel, intermediate steps do not occur in the neutralization of the acid in the presence of a complex-forming ion, the three protons being ejected together. This greatly simplifies the interpretation of the data. Furthermore, at the concentrations used (10^{-3} *M*) there was no indication of the formation of polynuclear complexes. The logarithms of the apparent stability constants

$$\left(k = \frac{[M(\text{tren})^{2+}]}{[M^{2+}]\,.\,[\text{tren}]}\right)$$

are as follows (their dependence on ionic strength should be small since the ligand is a neutral molecule):

M	Mn	Fe	Co	Ni	Cu	Zn	Cd	Hg
log*k*	5·8	8·6	12·8	14·6	18·8	14·6	12·3	~ 22·8

The order of the constants is in general the same as that observed with ammonia, ethylene diamine(en) and in other cases, in spite of the fact that a planar configuration is sterically impossible for the four nitrogen atoms surrounding the metal atom, which might be expected to lead to a decrease in the relative stability of the copper and nickel complexes.

	Mn	Fe	Co	Ni	Cu	Zn	Cd	Hg
$\log \frac{[M(\text{en})_2{}^{2+}]}{[M^{2+}]\,.\,[\text{en}]^2}$	4·8*	7·5*	10·7*	14·1*	20·1†	11·1†	10·2†	—
$\log \frac{[M(\text{NH}_3)_4{}^{2+}]}{[M^{2+}]\,.\,[\text{NH}_3]^4}$	—	—	5·3‡	7·8‡	12·6‡	9·1‡	6·9‡	~19·3

* Valid for 30° and ionic strength 1.
† Valid for 25° and ionic strength 1.
‡ Valid for 20° and ionic strength 0·1.

The loss of entropy on formation of a complex ion will be less when two or more ligand atoms are present in the same complex partner, but a comparison between the corresponding stability constants for ammonia, ethylenediamine[4] and β,β′,β″-triaminotriethylamine indicates that other factors, probably of a steric nature, are also of importance. It will be seen that the change in complex ion stability due to chelation varies considerably with the metal involved. The copper complex with β,β′,β″-triaminotriethylamine is actually less stable than that with ethylenediamine; an examination of the differences in the logarithms of the sets of stability constants given above indicates in the case of the ethylenediamine complexes a comparatively high stability of the copper and nickel complexes, and a low stability of the zinc and cadmium complexes. This is probably due to the tendency of copper and nickel to form complexes with a square configuration of the ligand atoms, whereas with zinc and cadmium the configuration is usually tetrahedral. In an ethylenediamine complex with a large central atom, the tetrahedral arrangement of amino groups will involve considerable strain in the two five-membered rings[5].

As in some other instances, the logarithms of the stability constants for β,β′,β″-triaminotriethylamine increase approximately linearly with the sum of the first two ionization potentials of the gaseous metal atoms, presumably indicating an underlying similarity between the electron energy-levels in the complex ions and in the corresponding metal atoms.

Details of our measurements with this and other 'complexons' will be published elsewhere.

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Formation and Decomposition of Ferrous αα′-Dipyridyl

A recent note in this journal[1] on the reaction between ferrous ion and αα′-dipyridyl (Dipy) induces us to report briefly on our investigations of this reaction. In a general way, our experimental results confirm the findings of Baxendale and George; they reveal, however, some new aspects of this reaction.

The decomposition of $\text{FeDipy}_3{}^{2+}$ in acid (HCl) solution may be represented at $[\text{H}^+] < 5 \times 10^{-2}$ fairly well by the equation

$$-\frac{d}{dt}[\text{FeDipy}_3{}^{2+}] = \{k_{d_0} + k_{d_1}[\text{H}^+]\}\,[\text{FeDipy}_3{}^{2+}];$$

indicating that beyond the monomolecular decomposition of $\text{FeDipy}_3{}^{2+}$, there is a reaction involving hydrogen ions. As the value of k_{d_1} decreases sensibly at higher hydrogen ion concentrations, it may be supposed that the rate-determining step is the monomolecular decomposition of an intermediate, $\text{FeDipy}_3\text{H}^{3+}$, rather than a bimolecular reaction between $\text{FeDipy}_3{}^{2+}$ and H^+. On this assumption the kinetics may be represented correctly up to *p*H 0 by the equation

$$-\frac{d}{dt}[\text{FeDipy}_3{}^{2+}] = k_{d_0}\,[\text{FeDipy}_3{}^{2+}] + k_{d_2}\,[\text{FeDipy}_3\text{H}^{3+}] =$$
$$\left\{k_{d_0}\left(1 - \frac{[\text{H}^+]}{[\text{H}^+] + K_3}\right) + k_{d_2}\frac{[\text{H}^+]}{[\text{H}^+] + K_3}\right\}[\text{FeDipy}_3{}^{2+}]_{\text{total}}.$$

The values of the constants at 25° and $\mu = 0{\cdot}33$ are $k_{d_0} = 7{\cdot}45 \times 10^{-3}$ min.$^{-1}$, $k_{d_2} = 8 \times 10^{-2}$ min.$^{-1}$ and the dissociation constant of $\text{FeDipy}_3\text{H}^{3+}$, $K_3 = 0{\cdot}6$. At $\mu = 0{\cdot}01$ the value of k_{d_0} decreases by about 10 per cent. The values of the activation energies are 29·5 kcal. for the reaction independent of hydrogen ion concentration and about 26 kcal. for that dependent on it, K_3 showing little or no dependence on temperature.

The formation of $\text{FeDipy}_3{}^{2+}$ from Fe^{2+} and HDipy^+ (αα′-dipyridyl HCl) at $[\text{H}^+] < 6 \times 10^{-2}$ follows approximately the equation

$$\frac{\Delta}{\Delta t_0}[\text{FeDipy}_3{}^{2+}] =$$
$$k_{f_0}[\text{Fe}^{2+}][\text{Dipy}]^3 + k_{f_1}[\text{Fe}^{2+}][\text{Dipy}]^2[\text{HDipy}^+] =$$
$$\left\{k_{f_0} + \frac{k_{f_1}}{K_a}[\text{H}^+]\right\}[\text{Fe}^{2+}][\text{HDipy}^+]^3\left(\frac{K_a}{K_a + [\text{H}^+]}\right)^3$$

(where $\Delta/\Delta t_0$ represents the initial velocity) if $[Fe^{2+}]$ is small in relation to $[HDipy^+]$. At higher concentrations of ferrous ions, an increase of these is not accompanied, however, by a proportional increase in velocity; on the contrary, after having reached a maximum value, the velocity decreases with a further increase of concentration of ferrous ions. Assuming that this behaviour is due to a rapid formation of an intermediate $FeDipy^{2+}$ which reduces the available concentrations of Fe^{2+} and $HDipy^+$ (and increases the concentration of hydrogen ions), it is possible to represent the kinetics within the experimental error of ± 10 per cent over a wide range of concentrations, especially with regard to the peculiar dependence on the concentration of ferrous ions, as shown in the table.

$[Fe^{2+}]$	1·37	5·5	55	165	555 × 10^{-5}
v_0 found	18·5	69	355	285	105 × 10^{-7} min.$^{-1}$
v_0 calcul.	18·7	68	331	310	107 × 10^{-7} min.$^{-1}$

$[HD^+] = 1{\cdot}66 \times 10^{-4}$, $[H^+] = 1{\cdot}60 \times 10^{-3}$, $T = 25°$, $\mu = 0{\cdot}33$

The values of the constants at 25° and $\mu = 0{\cdot}33$ are $k_{f_0} = 2{\cdot}7 \times 10^{15}$ min.$^{-1}$ and $k_{f_1} = 1{\cdot}75 \times 10^{12}$ min.$^{-1}$, using the values $K_a = 3{\cdot}7 \times 10^{-5}$ for the dissociation constant of $HDipy^+$ and $K_{FeDipy} = 2{\cdot}7 \times 10^4$ for the equilibrium constant of $FeDipy^{2+}$. At $\mu = 0{\cdot}01$ and $K_a = 4{\cdot}65 \times 10^{-5}$, K_{f_0} is about $1{\cdot}7 \times 10^{15}$.

If $FeDipy_2{}^{2+}$ is assumed to be the sole stationary intermediate, it is not possible to represent the kinetics in a satisfactory manner. It is, however, possible to regard $FeDipy_2{}^{2+}$ as second intermediate, but only if its stationary concentration is small in comparison with the concentration of $FeDipy^{2+}$. This assumption is even probable on account of the form of the second term of the velocity equation.

The final, rate-determining steps would then be

$$FeDipy_2{}^{2+} + Dipy \rightarrow FeDipy_3{}^{2+}$$
$$\text{and } FeDipy_2{}^{2+} + HDipy^+ \rightarrow FeDipy_3H^{3+}.$$

The overall velocity constant is, within the experimental error, independent of the temperature, K_{FeDipy} showing a small negative temperature coefficient.

The equilibrium constant

$$K = \frac{[FeDipy_3{}^{2+}]}{[Fe^{2+}]\,[Dipy]^3} = \frac{[FeDipy_3{}^{2+}]}{[Fe^{2+}]\,[HDipy^+]^3} \cdot \left(\frac{[H^+] + K_a}{K_a}\right)^3$$

is fairly constant only if $[Fe^{2+}] < [HDipy^+]$. With a correction, however, for the formation of $FeDipy^{2+}$, using the kinetic value of $K_{FeDipy} = 2{\cdot}7 \times 10^4$, K remains constant over a very wide range of concentrations, even when the uncorrected value is so low as $K/100$.

The average value of the equilibrium constant at 25° and $\mu = 0{\cdot}33$ is $K = 3{\cdot}8 \times 10^{17}$, decreasing to about $2{\cdot}5 \times 10^{17}$ at $\mu = 0{\cdot}01$. The kinetic value of K calculated as the coefficient of the velocity constants of the opposed reactions is $3{\cdot}6 \times 10^{17}$, in excellent numerical agreement with the value directly found.

The heat of formation of $FeDipy_3{}^{2+}$ at 25° is about 28 kcal. Thus the velocity constant k_{f_0} should have a small positive temperature coefficient (of less than 10 per cent per degree).

We shall try to find further confirmation of the existence of intermediates by investigating the kinetics in neutral solutions and by other methods. A full account of this work will be published elsewhere.

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Jan. 6.

Baxendale, J. H., and George, P., *Nature*, **162**, 777 (1948); see also Kolthoff, I. M., Lee, T. S., and Leusing, D. L., *Anal. Chem.*, **20**, 985 (1948), on the analogous reaction with *o*-phenanthroline.

The value of K_{FeDipy} obtained by Dr. Krumholz from kinetic measurements agrees very well with a value of $1{\cdot}64 \times 10^4$ (independent of temperature) which we have obtained from equilibrium measurements based on the incomplete formation of $Fe(Dipy)_3{}^{2+}$ in excess ferrous ion reported earlier. It appears from our results that it is not possible to obtain appreciable amounts of $Fe(Dipy)_2{}^{2+}$; hence a precise value of K_{FeDipy_2} cannot be obtained, but only its upper limit, $K_{FeDipy_2} \ngtr 10^5$.

Over the *p*H range 0–2·5, our results on the dissociation of $Fe(Dipy)_3{}^{2+}$, in hydrochloric acid solution agree with those of Dr. Krumholz, although we believe that the simple explanation involving the formation of the intermediate $Fe(Dipy)_3H^{3+}$ is insufficient to explain the following observations. First, the first-order dissociation-rate constants at 35° C. depend on the acid used, and the differences cannot be accounted for by the differing hydrogen ion activities. Secondly, above 1·0 *N* hydrochloric acid, the rate constants are far below the predicted values based on $Fe(Dipy)_3H^{3+}$ formation. For example, at 25° and 35° C., the maximum first-order constants at high hydrogen ion concentration on this assumption (k_{Dipy_2}) are $8{\cdot}0 \times 10^{-2}$ and $33{\cdot}4 \times 10^{-2}$ min.$^{-1}$, whereas our observed values are $4{\cdot}4 \times 10^{-2}$ and $21{\cdot}6 \times 10^{-2}$ min.$^{-1}$ independent of the acid concentration. Experiments on dissociation in the presence of high salt concentrations at about 0·2 *N* acid show the rate constants to be little altered, so these effects cannot be attributed to kinetic salt effects.

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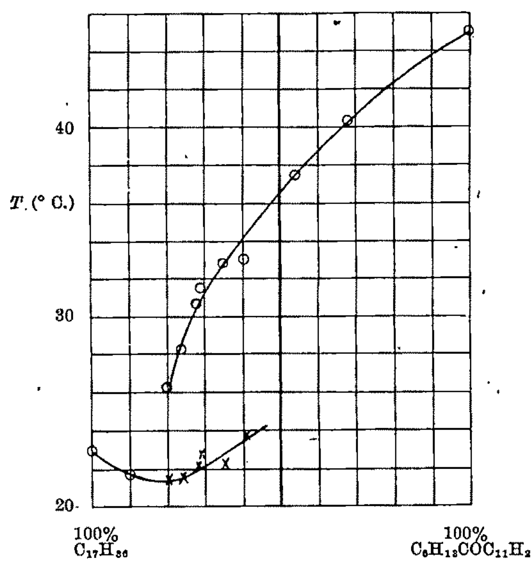
A Co-operative Transition in a Mixed Ketone Shown by a Change of Dielectric Constant

In a paper on the dielectric properties of dipolar solids, Fröhlich[1] considers the theory of second-order transitions in long-chain ketones. Starting from the crystal structure of these materials, he shows the possibility of co-operative transitions in the solid, and derives an expression for the behaviour of the dielectric constant at such a transition. This theory is derived for pure ketones; but so far no ketone has been found to show a transition of the type in question, the energy conditions being apparently unfavourable. However, such a transition has now been found in a binary mixture of a ketone and a paraffin, namely, 25 per cent of $C_6H_{13}COC_{11}H_{23}$ with 75 per cent of $C_{17}H_{36}$.

The mixture in question has two phases when in equilibrium, the main component being a solid solu-



o—o—, Stable melting points; ×—×—, metastable melting points

Fig. 1. Melting points of mixtures of $C_6H_{13}COC_{11}H_{23}$ and $C_{17}H_{36}$

tion of 10–20 per cent of ketone in paraffin, and the other predominantly the ketone. However, equilibrium is reached only after prolonged annealing, and the mixture can be quenched as a metastable homogeneous solid solution of ketone in paraffin. The physico-chemical properties of the mixture follow most clearly from the melting point diagram of the binary system $C_6H_{13}COC_{11}H_{23} + C_{17}H_{36}$ (see Fig. 1).

The dielectric constant of the mixture of 25 per cent ketone and 75 per cent paraffin was measured at two frequencies, 3 × 10^6 and 1 × 10^3 cycles/sec. A capacitor was used which allowed rapid quenching of the specimen. Fig. 2 shows a typical curve, obtained, in the case shown, on a quenched specimen at 3 × 10^6 cycles/sec. The results are independent of frequency, within the limits of error. It may be seen that within a considerable temperature interval below the melting point the dielectric constant behaves as in the liquid; the discontinuity at 22° C., the metastable melting point, appears to be due to volume changes and macroscopic orientation effects. The drop of the dielectric constant at about 4° C., which is independent of frequency, indicates a chan of structure from one with mobile dipoles to o with immobile dipoles, the changes being gradu over a temperature interval. The values measur for the annealed, two-phase form are not material different from those shown in Fig. 2 for the met stable form, since the main component of the mixtu is still a solid solution of the ketone in paraffin.

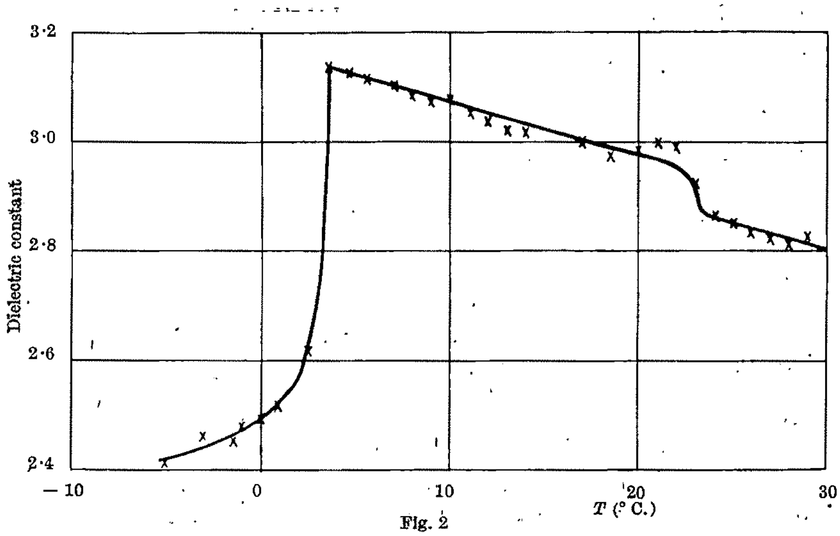


Fig. 2

The measurements in question are only preliminar The necessity of quenching the specimen involved reduction in the precision of measurement of bo the dielectric constant and temperature. It is hop to repeat them more exactly. However, they sho clearly the existence of a co-operative transiti analogous to that predicted by Fröhlich.

The existence of second-order transitions in paraffi is, of course, well known through the work of Mülle Ubbelohde[3] and others. The novelty of the prese result consists in the fact that the transition fou lies far below the melting point and that it can followed by means of the dielectric constant, so th a theoretical treatment on the lines suggested Fröhlich may be possible.

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Nov. 8.

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[1] Fröhlich, H., *Proc. Roy. Soc.*, A, **185**, 399 (1946).

[2] Müller, A., *Proc. Roy. Soc.*, A, **138**, 514 (1932).

[3] Ubbelohde, A. R., *Trans. Farad. Soc.*, **34**, 292 (1938).

Water Layers in Vermiculite

GRUNER[1] has shown that vermiculite consists talc-like layers, 9·26 A. high, alternating with wat layers (4·95 A.), the total water content of t mineral being in the region of 20 per cent. Theories[2] as to the nature of the water layers have found dif culty in explaining the observation[1,2,3] that, wh vermiculite is heated at 110° C., about half the wat is removed without apparently affecting the di fraction pattern. It can be shown, however, that change in the structure does, in fact, take place duri this treatment; but that the rapid rehydration whi occurs on contact with normal atmospheric conditio tends to obscure it. Thu while the diffraction patter of unheated and rehydrat samples are identical, a po der specimen heated at 110° and sealed in a thin gla tube before rehydration c occur does not give t usual 14·2 A. basal reflexi of vermiculite but one 11·8 A. corresponding to water-layer thickness of 2· A., which is about half t original value. A sing flake similarly treated sho the 11·8 A. reflexion to associated with a regul sequence of higher order that is to say, it represen a real spacing and is n a diffraction effect from i timately mixed layers of di ferent sizes[4]. It is clear, therefore, that removal of half the water is accompanied by replacement of an original double water-layer by a single layer.

The reason for the rapid and spontaneous rehydration which takes place on contact with atmospheric moisture is not so obvious, but appears to be bound up with the very high cation-exchange capacity of this mineral, which is comparable with that of montmorillonite. Tests made in this laboratory on several vermiculites have shown that the mineral has a maximum exchange capacity in the region of 130 m.equiv. per 100 gm., and that, in natural vermiculite, the exchange positions are always occupied by Mg^{2+} ions, the frequency of occurrence of these ions between the basal-plane surfaces being about 1·17 per unit cell.

In natural magnesium-saturated vermiculite, the height of a water layer is sufficient for each magnesium atom to be surrounded by a single hydration shell of six close-packed water molecules arranged octahedrally. Since the chemical formula[5] of vermiculite requires 16 water molecules per unit cell, there will be approximately 14 water molecules between the basic talc-like layers for each exchangeable magnesium ion and, for each octahedral group of magnesium-shell waters, approximately 8 'extra-shell' water molecules less tightly bound. According to the chemical formula of vermiculite, 30 per cent of the total water consists of hydroxyl groups, so that these 'extra-shell' water molecules would constitute almost half the total water content of the mineral, the half presumably which is released at 110° C.

The evidence suggests that, on removal of these 'extra-shell' molecules, the octahedral groups surrounding the exchangeable magnesium ions spread out over the basal-plane surfaces in a single layer; but that the strong tendency of the magnesium ions to become rehydrated causes reversion to the original structure as soon as extra moisture becomes available. Further, if the exchangeable magnesium ions occurring in natural vermiculite become hydrated in the manner suggested and their calculated frequency is of the right order, an inadequate amount of space would seem to be left for the development on any appreciable scale of Hendricks and Jefferson's[3] hexagonal groups of water molecules.

The theory outlined above requires that the configuration of the water layers in vermiculite should be largely determined by the type of exchangeable ion present, and this is, in fact, found to be so. Thus, replacement of the magnesium ions in exchange positions by monovalent and divalent ions causes changes in the c-dimension of the unit cell, as seen on an X-ray powder photograph; so that after leaching with a potassium salt, for example, the strong 14·2 A. basal reflexion of magnesium-saturated vermiculite is replaced by a diffuse line centred on 11·0 A., while ammonium-saturated material gives a broad line at about 10·6 A. and barium-saturated material a line at 12·3 A.

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Nov. 10.

[1] Gruner, J. W., *Amer. Min.*, **19**, 557 (1934).
[2] Gruner, J. W.. *Amer. Min.*, **24**, 428 (1939).
[3] Hendricks, S. B., and Jefferson, M. E., *Amer. Min.*, **23**, 863 (1938).
[4] Hendricks, S. B., and Teller, E., *J. Chem. Phys.*, **10**, 147 (1942).
[5] Hendricks, S. B., and Jefferson, M. E., *Amer. Min.*, **23**, 851 (1938).

Sublimation in Outdoor Air and Seeded Sublimation

At intervals over the past twelve months, expansion chamber tests of the threshold temperature for the formation of ice crystals in supersaturated air have been carried out at this College. Of the various weather conditions experienced, it was found that with strong sea winds (N. and S., 5 or more on the Beaufort scale), the threshold value remains constant at − 41·2° C., which is the value found previously for nuclei-free air[1]. In other weather conditions the threshold is variable between − 41·2° C. and − 32·2° C. The latter is the value already found for the ground layer of air in England. Diurnal variations are sometimes as large as 4° C. It appears that there is a whole 'spectrum' of sublimation nuclei in polluted air.

In view of the recent discovery of the seeding properties of silver iodide[2], its tendency to initiate the sublimation of water vapour was tested in an expansion chamber and on the test plates of hoar-frost hygrometers.

(*A*) *Expansion chamber tests.* Samples of chemically pure silver iodide were evaporated from a platinum wire, and expansion chambers were ventilated with air rich in silver iodide micro-crystals. The threshold sublimation temperature was found to be − 2·9° C. (± 0·1° C.). A decrease in the final temperature of a few tenths of a degree centigrade below this critical value practically fills the chambers with ice dust.

(*B*) *Frost point hygrometer tests.* Seeding of the surfaces of frost-point hygrometers with silver iodide micro-crystals was performed by condensing silver iodide (evaporated from a platinum wire) on polished surfaces. In testing various sizes of the crystals, it was found that the most active surface is one which is only just 'sensitized' by silver iodide (in the terminology of molecular beam physicists), that is, when the crystals are invisible. On such a surface, when freshly prepared, sublimation begins at − 2·9° C. (± 0·05° C.). At this critical temperature only a few ice crystals start to grow, and when air, supersaturated in respect to the dew point, was admitted over the surface, supercooled water started to deposit between the crystals, leaving clear areas closely around each crystal. With thimble temperatures above − 2·9° C., only supercooled water deposits on the thimble. When the thimble temperature is only 0·2° C. lower than the critical value, the sublimation activity of the surface is so high that it is impossible to deposit supercooled water even if very moist air is admitted to the hygrometer. The surface is covered at once with a multiplicity of ice crystals, resembling fine emery. The ageing of surfaces seeded with silver iodide proceeds relatively slowly. Twenty-four hours after evaporation of silver iodide and after many ice and water depositions on the surface, its sublimation threshold dropped to − 5° C. After a week of use the threshold value was − 10° C. With larger silver iodide crystals the critical temperature is somewhat lower, and with a quite coarse, clearly visible silver iodide deposit is − 5·5° C. The ageing process of coarser surfaces is similar to the 'sensitized' surfaces.

Though the seeding ability of silver iodide is not as high as that of zinc or cadmium, evaporated *in vacuo*[3], the surfaces seeded with silver iodide have the great practical advantage of being relatively lasting and very easy to reproduce. Sublimation on the surfaces seeded with silver iodide commences at temperatures somewhat lower than the frost point of the air under investigation, that is, between the frost point and the dew point, though generally closer to the former. Even with a seeded surface, therefore, the frost point should be determined by observation of the temperature at which ice crystals *present* on the surface are in equilibrium with the air under test, and *not* by determining the temperature at which ice crystals first appear on the surface[4]. In spite of this, the process of humidity measurements at temperatures between 0° and − 60° C. by the use of surfaces seeded with silver iodide is much simplified. Hitherto, such measurements have required a rather skilled observer owing to the difficulty of distinguishing between ice and supercooled water, either of which may be deposited on an unseeded surface in this temperature range. On the seeded thimble, this uncertain region is restricted to only a few degrees below freezing, when the error due to confusion between saturated vapour pressure of ice and water would be relatively small.

I wish to thank Mr. H. D. C. Waters, lecturer in chemistry at this College, for preparing samples of silver iodide from reagents of analytical purity.

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Aug. 4.

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[1] *Proc. Roy. Soc.*, A, **190**, 137 (1947); *Nature*, **160**, 198 (1947); *Nature*, **161**, 62 (1948).

[2] *J. App. Phys.*, **18**, 593 (1947).

[3] *J. Glaciology*, **1**, 53 (1947).

[4] *Proc. Roy. Soc.*, **185**, 144 (1946); *Proc. Phys. Soc.*, **60**, 52 (1948).

Radar Observation of Heavy Rain

IN view of the article on this subject which appeared in *Nature* of March 5, p. 372, it may be stated that the systematic exploration of clouds and rainfall by means of radar has been proceeding actively in Great Britain for some years past, though relatively little has been published, apart from official reports and memoranda. The photographs shown in the article referred to are characteristic of rainfall from a moving cold front.

Following upon successful experiments by the Telecommunications Research Establishment of the Ministry of Supply, a radar station at East Hill, near Dunstable, was taken over by the Meteorological Office for meteorological investigations. The station is equipped with A.M.E.S. Types 13 and 14 radar, operating on a wave-length of 10 cm. and using a pulse of 2-microsec. duration. The presentation on the display tube of the Type 13 gives range and height of the echo, while that of the Type 14 gives the bird's-eye view or PPI display. A simple switching device enables the Type 13 tube to be used to give the intensity of the echo, and in the cases under investigation the maximum intensity in the vertical column is usually examined particularly. Certain meteorological stations in the neighbourhood of East Hill are equipped for measuring rate of rainfall and drop-size, while the upper air data provided by the regular sequence of *radio sonde* ascents at the network in the British Isles are available to enable the phenomena to be related to the general meteorological situation.

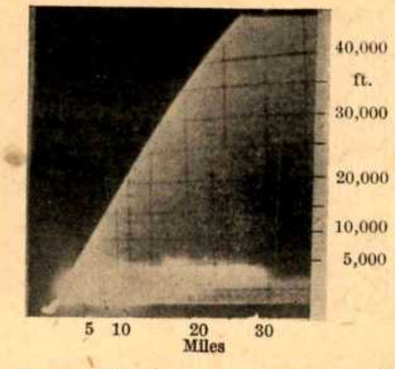

Fig. 1. January 29, 1948, at 1044 G.M.T.; bearing 246° T.

In addition, on selected occasions, the echo-producing clouds are simultaneously explored by an aircraft provided by the Royal Aircraft Establishment at Farnborough.

The object of the investigations is the study of the physical processes going on in clouds, including in particular the relation of the echoes to vertical currents and to icing which might constitute dangers to aircraft.

The results to date and earlier work which has been the subject of official reports cannot be described within the space available here; but two characteristic types of vertical sections are shown in the accompanying three photographs. Horizontal distance in miles is shown below the photographs and height in feet at the side.

Fig. 1, showing the 'bright band' effect, is found with layer-type clouds such as occur with weak and slow-moving or quasi-stationary fronts. Such bands are of limited vertical development, rarely giving responses down to ground-level and sometimes associated with a brighter band near the freezing-level. They are associated with relatively weak vertical air currents.

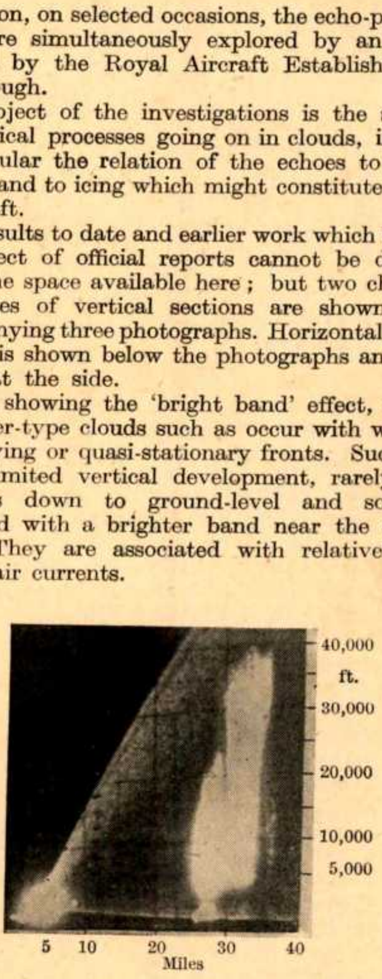

Fig. 2. July 30, 1948, at 1544 G.M.T.; bearing 194° T.

The outstanding feature of Fig. 2, on the other hand, is the appearance of strong vertical columns of echo, with clear-cut vertical edges and no indication of any 'bright band' phenomena. The more distant echo seen here comes from a thunderstorm extending to 40,000 ft., and the tendency to diverge near the top will be noted. The nearer echo was from a strongly developing new cumulo-nimbus. Such clouds have apparently liquid water drops at all heights, since they have been found to cause icing on the exploring aircraft.

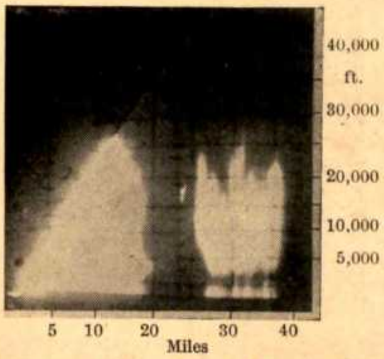

Fig. 3. June 10, 1948, at 0923 G.M.T.; bearing 176° T.

Fig. 3 relates to two extensive thunderstorms, one going on overhead and around the station, the other some 25–36 miles distant. The small isolated echo between at a height of about 17,000 ft. is from the observing aircraft, which is about to enter the second thunderstorm. In this case the accelerometer records from the aircraft appear to indicate that the peaks of the vertical columns were associated with strong upcurrents, the troughs with down-draughts.

This note is communicated by permission of the Director of the Meteorological Office.

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Frictional Electrification of Dust and Pre-ignition in the Hydrogen Engine

THE experiments on the frictional electrification of sand described by E. W. B. Gill[1] are of interest in respect of the pre-ignition and combustion knock generally observed when hydrogen is used as the fuel for an Otto-cycle internal combustion engine. Pre-ignition in the hydrogen engine is defined as ignition occurring during the induction stroke, that is, before the inlet valve closes.

Engine experiments by R. O. King, W. A. Wallace and B. Mahapatra[2] demonstrated that the effects mentioned were not obtained in the absence of carbon dust derived from pyrolysis of the lubricating oil even at a compression ratio of 10 : 1 and when using hydrogen–air mixtures in any ignitable proportion.

The engine experiments were resumed in September last, when the laboratory atmosphere was heavily impregnated with dust arising from the breaking up of part of the concrete floor. Pre-ignition was so severe that they could not be continued.

An air cleaner from an 85-h.p. motor-car engine was then fitted to the air intake of the C.F.R. experimental engine, which aspirates about 1/15 as much air. There was then no pre-ignition, and combustion knock was reduced sufficiently to permit completion of the experiments. The cleaner was of the type in which, on change of direction of the air stream, the particles of dust are thrown on to a sticky surface. In view of the oversize of the cleaner, it may be assumed that the larger particles only were removed from the air stream.

The engine experimental results, if interpreted in the light of those described by E. W. B. Gill, indicate that pre-ignition in the hydrogen engine when aspirating dust-laden air is due to discharges of electricity as between larger particles carrying negative charges and small ones carrying positive charges, remembering that potential differences would be increased by the friction between particles due to the air–hydrogen mixture passing the restriction of the inlet valve at high velocity. The air cleaner removes the large particles and pre-ignition is prevented accordingly.

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[1] *Nature*, **162**, 568 (1948).

[2] *Can. J. Research*, F, **26**, 264 (1948).

The 'Complex Indicatrix'

IN discussing the application of Drude's 'complex indicatrix' for reflected light, M. Berek[1,2] originally extended the use of this term to include the two sheets representing the separate values for n and k. Thus he says, "The [cubic] complex indicatrix consists of concentric spheres with radii n and k". Strictly, the cubic complex indicatrix is, as he states elsewhere, a sphere with the complex radius n-ik, and is not itself geometrically representable. The n and k surfaces are representable for the more symmetrical crystals though not for the general case, and in some ways these surfaces take the place of the indicatrix of a transparent crystal. Nevertheless, this use of the term 'complex indicatrix' seems too wide, and I think this is Berek's opinion, for on looking through his later summary (1937)[3], I have not been able to find the term so used, though there is no direct reference to the question. No special designation is used for the curves there plotted (pp. 59, 60) and I have recently cited these under Berek's former nomenclature[4]. A term such as 'representative surfaces' for n, k, R, etc. would, however, appear to be more satisfactory.

As often happens, differences in notation have arisen in the accounts given by different workers. Berek consistently employs k for absorption coefficient, $\varkappa$ for absorption index ($k = n\varkappa$). In the English translation of Drude[5] (p. 360) $\varkappa$ is termed the coefficient of absorption, but later (p. 371) it is called the index. L. Capdecomme and J. Orcel[6] use χ in place of Berek's k and term it the "indice d'extinction". R. Galopin[7] uses k in place of Berek's $\varkappa$ and terms nk the "coefficient d'absorption". I understand that a further discussion from the mathematical side may be available in the new edition of the "Lehrbuch der Erzmikroskopie", Bd. I.[1].

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[1] Berek, M., in Schneiderhöhn, H., and Ramdohr, P. "Lehrbuch der Erzmikroskopie", 1 (Berlin, 1934), see p. 130.

[2] Rinne, F., and Berek, M., "Anleitung zu optischen Untersuchungen . . .", 16 (Leipzig, 1934).

[3] Berek, M., *Fort. Min. Krist. Petr.*, **22**, 1 (1937).

[4] Hallimond, A. F., "Manual of the Polarizing Microscope", 91 (York, 1938).

[5] Drude, P., "The Theory of Optics" (English trans. by C. Mann and R. Millikan, London, 1902).

[6] Capdecomme, L., and Orcel, J., *Rev. optique théor. et instr.*, **20**, 47 (1941).

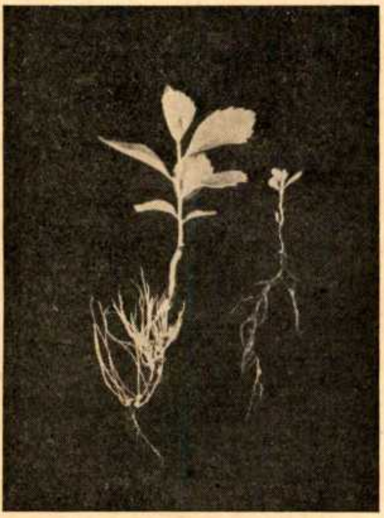
[7] Galopin, R., *Bull. Suisse Min. Petr.*, **27**, 190 (1947) (see p. 197).

Root Nodules of Bog Myrtle or Sweet Gale (*Myrica Gale* L.)

PREVIOUS investigations[1] on the root nodules which commonly occur on *Myrica* spp. have referred chiefly to the structure and cytology of the nodules and to the identification of the endophyte. Little attention appears to have been paid to the possibility of fixation of nitrogen being associated with the nodules. Bottomley[2], after visual comparison of the growth made by plants (some with nodules, some without) transplanted from the natural habitat into a nitrogen-deficient soil, concluded that fixation of nitrogen had occurred. This finding deserves confirmation and amplification.

Satisfactory germination has been obtained with bog myrtle seed pre-treated by exposure in moist peat to a temperature of 2° C. for six weeks. Afterwards it was noted that this agreed with the experience of Barton[3] using seed of *M. carolinensis*. Seedlings were transplanted in May to water culture in Crone's solution (nitrogen-free formula, *p*H initially 5·0) and inoculated with a suspension of crushed nodules from field plants. Nodules appeared in three to four weeks. Seedlings not so inoculated did not develop nodules and showed very little growth, whereas all nodulated plants grew strongly (see photograph). Eight nodulated plants harvested after sixteen weeks growth in water culture showed a mean dry weight of 245 mgm. and a total nitrogen content of 7·3 mgm. per plant. Corresponding means for five non-nodulated plants were 6 mgm. and 0·1 mgm. respectively. These data strongly suggest that fixation of atmospheric nitrogen is associated with nodulated plants.

Young nodules developing under the above conditions show a red colour identical in hue with the pigmentation (presumably anthocyanin) which also appears in the hypocotyl of the seedling. A curious feature is that the roots which, in *Myrica* spp., develop from the tips of the nodules grow upwards (see photograph) and eventually project from the surface of the culture solution. The other roots display normal orientation. A parallel seems to be presented by the observations of McLuckie[4] on the tubercle roots of *Macrozamia*, which also exhibit upward growth.



Plants of bog myrtle (sweet gale) after twelve weeks growth in nitrogen-free water culture: left-hand plant with nodules, right-hand plant without nodules. × ½

This investigation, to be continued, is associated with work on leguminous root nodules which is receiving support from the Agricultural Research Council.

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Nov. 12.

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[3] Barton, L. V., Contr. Boyce Thompson Inst., **4**, 19 (1932).

[4] McLuckie, J., *Proc. Linn. Soc. N.S.W.*, **47**, 319 (1922).

Preparing for the Occurrence of New Races of Rust

IN Australia within the last eight years there have been two important cases of the breakdown of resistance to rust in wheat. The first was in 1942 when Eureka 2, a variety which, up to that time, had been highly resistant, suddenly became susceptible. This new stem rust has, on account of its close relationship with race 126, been designated as race 126*B* (unpublished data). The second case was in 1945, when Gabo was attacked by leaf rust (*P. triticina*) for the first time in Australia. This is also a rust unlike those previously present.

Eureka 2 and Gabo have proved particularly popular with growers, for under rust-free conditions in northern New South Wales, both are capable of high yields, they have a good straw and give a flour of satisfactory quality. The incorporation of leaf-rust resistance into Gabo is receiving immediate attention, and despite the big reduction in acreage sown to Eureka, we are endeavouring to add stem-rust resistance to it. These programmes will not be completed for some years yet and serious losses from rust may occur in the interim. Moreover, changes in the rust flora may render Gabo susceptible at any time.

It seems that when such satisfactory varieties have been bred, steps should be taken to prepare them for the possible occurrence of new races of rust. Although it is impossible to breed for resistance to specific races until they appear, we are working to a programme which it is hoped will give reasonable assurance of having, in a few years, a series of varieties equal to Gabo and Eureka 2 in yielding ability, and comprising certain ones resistant to new races of rust when they arise.

The problem of adding stem-rust resistance to Eureka 2 is a simple one, and already we have obtained from a back-cross of Gabo × Eureka 2 three resistant lines that seem the equal of the recurrent parent. However, it is considered unwise to concentrate solely on the one source of resistance, as there is no certainty that Gabo will continue to be resistant in the event of another rust culture greater in its parasitic capabilities than race 126*B*. To prepare for such an eventuality, we are using, in addition to Gabo, a diverse collection of varieties for crossing with Eureka 2. Varieties in this collection are known to have a fairly comprehensive stem-rust resistance under Australian conditions and include the following: Hofed, Fedweb, Celebration, Charter, *T. Timopheevi* × Steinwedel, Kenya 117*A*, wheat × rye, Khapli Emmer × Steinwedel and *Triticum* × *Agropyron*. These and others are being crossed individually ith Eureka 2, and in each case the resistant progeny ill be back-crossed to Eureka 2 until sufficient of s genotype has been recovered. These recovered lines iould all be morphologically similar, but during the iurse of the selection it may be possible to include marker gene so that at a glance one can tell from hich source the resistance has been added. At :esent, it is not known whether all the resistant arieties given above have different genes for rust sistance. In at least certain of them, the genes opear to be allelic. Despite the absence of this iformation the programme will not be affected, for iould a new rust arise, then all those recovered nes that prove susceptible will be discarded. It most unlikely that all resistant progenies obtained om such a diverse collection of parents will succumb t one time to the same rust. One or more of the irviving ones will, of course, be released for cultivaon.

Preparing Gabo for the occurrence of a new strain f stem rust has not proved so simple, as this variety already resistant to the Australian races. Connuous back-crossing to Gabo, using, say, Kenya 17*A* as the non-recurrent parent, would probably nly recover the present Gabo resistance, unless there as available for test a specific race to which Gabo as susceptible. As such is not present here, and it eems unwise to introduce it, the programme is being arried out in two steps. The progeny of the Gabo × ureka 2 cross mentioned above has been back-rossed twice to Gabo and selection has been for tem-rust susceptibility. After one more back-rossing, probably sufficient of the Gabo genotype ill have been recovered. To this susceptible strain f Gabo will be added in turn the resistance of those arieties of the above collection. These recovered, esistant strains of Gabo, together with the resistant abo now being cultivated, should give some hope hat even if a new race of rust does arise, one or nore varieties will be immediately available capable f resisting it.

This programme is not being complicated by leaf-ust resistance at present, as this latter is a separate roject. It is proposed to combine leaf- and stem-ust resistance as soon as practicable. A method losely resembling the one outlined for Gabo and ureka 2 is being followed in breeding for rust resistnce in linseed. Punjab is taken as the standard usceptible high-yielding variety. The resistance of everal carefully selected parents is being added by he usual method of back-crossing.

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Effect of Crude Benzene Hexachloride on Wheat Seedlings

There are numerous published references to the mfortunate effects of benzene hexachloride on the levelopment of plants, both from seed[1-3] and from he tuber[4]. In only one of these reports, however, s any reference made to the question of the exact dentity of the constituent of the crude material vhich is responsible for these effects[3]. Of the many somers and impurities present in the crude material, mly the gamma isomer is recognized as important is an insecticide. If the effects of benzene hexahloride on plants are due to some other constituent, the potentialities of the material as an agricultural insecticide may be greatly extended. To settle this question, experiments were begun in March 1948 by treating seed wheat with various preparations and constituents of benzene hexachloride, and observing the effects on germination and development.

The evidence indicates that plant deformation is not due to the gamma isomer. A mixture of trichlorobenzenes prepared by alkaline breakdown of alpha benzene hexachloride possesses this activity in far higher degree, relatively small doses causing the ultimate symptom, inhibition of germination. The material is active in the vapour phase. Possibly this active material is 1,3,5-trichlorobenzene, which has been shown to have this property[5], possibly another trichlorobenzene or some other volatile breakdown product of benzene hexachloride. Under natural conditions it is produced most rapidly by the breakdown of the gamma isomer, more slowly by the alpha isomer and at a quite unimportant rate, if at all, by the beta isomer. The material is effective in such low concentration that it may well have applications in the field of selective weed-killers. The exact nature of the material is still under investigation and detailed results will be published shortly.

Benzene hexachloride preparations for wheat-seed treatment against wireworms should be materials of high gamma content, applied at the minimum practical rate for control. The hazards accompanying their use are likely to be increased by storage after treatment, especially if ventilation is inadequate, by exposure to sunlight and by deficient moisture or high *p*H of the soil.

I am indebted to Dr. J. H. Whyte, of the Department of Botany, University of Alberta, for his help on botanical aspects of this work; also to Prof. D. L. Garmaise, of the Department of Chemistry, University of New Brunswick, and to Messrs. Canadian Industries, Ltd., who kindly provided many of the chemicals used.

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Persistence of Pyrethrins and Gamma Isomer of Benzene Hexachloride

In view of Beckley's advocacy of pyrethrum dust for weevil control in bagged grain[1], the following comparison with the gamma isomer of benzene hexachloride is of interest.

Laboratory tests were made against *Sitophilus granarius* using wheat dusted with 0·5 and 1·0 p.p.m. gamma benzene hexachloride from a commercial benzene hexachloride dust diluted with kaolin, and with 5, 10, 20 and 27 p.p.m. pyrethrins from powdered pyrethrum flowers. The treated grain was kept in open jars for 2–16 weeks at 28° C. and 70 per cent relative humidity before introducing the insects, and the jars were then closed. Mortality counts were taken at intervals up to 28 days. The tests were run in quadruplicate and the usual precautions observed.

Period of airing before infestation. weeks	2		10		16	
Count made......days after infestation	10	28	10	28	10	28
Treatments and corresponding absolute mortalities, %						
Benzene hexachloride, gamma isomer, 1·0 p.p.m.	100	—	87	97	86	94
Benzene hexachloride, gamma isomer, 0·5 p.p.m.	95	97	43	61	10	17
Pyrethrins, 27 p.p.m.	76	81	28	38	3	1
Pyrethrins, 10 p.p.m.	8	12	9	8	—	0
Control, no dust	2	7	4	8	0	5

Results, detailed in the table, show not only that gamma benzene hexachloride at 0·5 p.p.m. is more toxic than 27 p.p.m. pyrethrins, but also that it is more persistent. The Agricultural Research Council finds that gamma benzene hexachloride at this dosage is free from health hazard.

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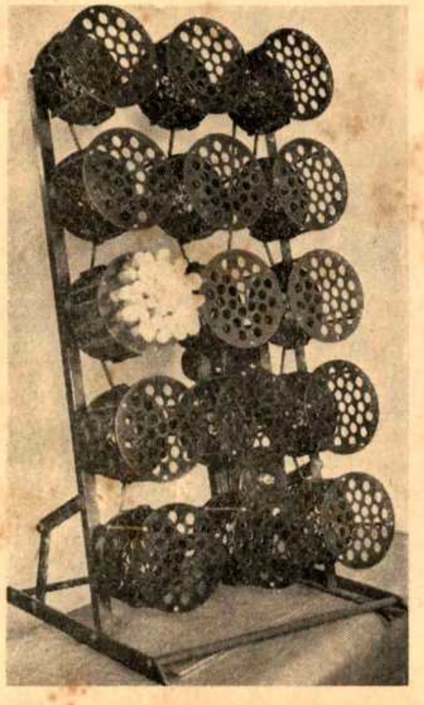
[1] Beckley, V. A., *Nature*, **162**, 737 (1948); *E. Afric. Agric. J.*, **14**, 71 (1948).

A Rotating Test-Tube Apparatus for Experimental Fermentations

THE examination of different species or mutants of moulds calls for a simple and compact apparatus in which fermentations can be conducted in large numbers. The 'shaken flask' technique[1] has proved of great value, but even this requires a good deal of space if many tests are to be carried out at the same time.

To meet this special need a simple apparatus has been devised by which a large number of test-tube cultures can be satisfactorily aerated by rotation.



Each unit consists of a rack composed of two 6-in. diameter disks separated by supporting rods 3½ in. long. Both disks are drilled with 31 oversize ⅝-in. holes to carry test-tubes of that size. The units are mounted on ball races to reduce friction and are driven from a pulley by a suitable drive. A convenient apparatus consists of fifteen such units mounted on a steel frame, as shown in the photograph. Such an apparatus will fit into a laboratory incubator and will permit 465 fermentations to be made simultaneously. The degree of aeration can be changed by altering the inclination of the tubes through 16°.

From numerous trials we found that, with 5-ml. media in each tube, an angle of inclination of 11·5° and a speed of rotation of 100–120 r.p.m. gave satisfactory conditions for growing *Streptomyces griseus*.

The growths and titres obtained in this way were comparable with those obtained by other methods of carrying out small-scale fermentation.

I wish to thank Dr. A. J. P. Martin for his suggestions, and Mr. L. C. Maltby for making the apparatus.

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Another Little-known History of Botany

THE recent review by Prof. F. E. Fritsch[1] of "A Forgotten History of Botany" by Karl F. W. Jessen has reminded me of another little-known book on the same subject, published in 1871 in Paris, under the signature of "L. G.". It is entitled "Précis de l'Histoire de la Botanique", and is one of the seventeen volumes of the botanical encyclopædia "Le Règne Végétal" published by a group of botanists of that period. The author of the "Précis" is perhaps the editor of the encyclopædia, L. Guérin, whose name appears at the bottom of the title-page; but this is merely a guess based on the initials which are used. The book seems to have been inspired mainly by Pritzel's first edition of "Thesaurus literaturæ botanicæ" (1851), but the "Précis" is stated to contain the titles of numerous publications unknown to Pritzel, especially French publications.

The book contains 535 pages, and some supplementary maps on plant geography. Its subject-matter is chronologically arranged and covers the whole field of history, beginning with "Before the Greek Civilization" (Chapter 1) to the nineteenth century (Chapter 7). There is an index comprising the names of all the authors cited in the book.

This history of botany is probably not as readable as Jessen's, since long lists of names are rather frequent, especially lists of titles of publications. However, I feel that the book is useful for purposes of reference, and I have often made use of it. If some person could give me precise information about its author, I should be grateful.

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[1] *Nature*, **163**, 115 (1949).

THE OIL-DROP METHOD FOR THE DETERMINATION OF THE ELECTRONIC CHARGE

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It is generally accepted that the discrepancy between Millikan's[1] early value of the electronic charge, e ($4{\cdot}770 \times 10^{-10}$ E.S.U.), and the value derived by the X-ray method ($4{\cdot}8021 \times 10^{-10}$ E.S.U.[2]) can be accounted for by the uncertainty in the value of the viscosity of air at 23° C. (η_{23}). There exist, however, wide variations in the results obtained by different workers using the oil-drop method, even when the ratios $e^{2/3}/\eta_{23}$, which are independent of the absolute value of the viscosity, are compared. For example, the following values of $e^{2/3}/\eta_{23}$ have been derived from the results published by the authors: Millikan[1] $334{\cdot}96 \times 10^{-5}$; Bäcklin and Flemberg[3] $334{\cdot}12 \times 10^{-5}$; Ishida, Fukushima and Suetsugu[4] $336{\cdot}65 \times 10^{-5}$; Hopper and Laby[5] $335{\cdot}09 \times 10^{-5}$ (e E.S.U., η_{23} C.G.S.). In view of the large variation in these values, in spite of the internal consistencies of the separate experiments, it seemed desirable to make a systematic study of the oil-drop method itself, to find, if possible, the reasons for these differences and also an unexceptionable value of $e^{2/3}/\eta_{23}$.

In this study, the velocities of a drop were measured when acted on by the earth's gravitational field and by the combined action of the gravitational field and an almost vertical electrical field. The velocities were measured by photographing the drop with the aid of a spark which was triggered at intervals of 1/5 sec. The hole in the top plate of the condenser through which the oil drops entered the field of view was 0·368 mm. in diameter and displaced 2 mm. from the centre. Measurements of drop velocities were made in the centre of the condenser, a millimetre or so sideways from the hole, thus ensuring that the distortion produced by the hole on the electric field was negligible[6]. Care was taken to avoid an accumulation of oil on the lower plate of the condenser, as this also produces a field distortion. The condenser plates were slightly tilted in the direction of the optic axis of the camera, so that under the repeated action of the fields the drop was gradually brought into and finally out of focus. The plates were also tilted in a direction at right angles to the optic axis, so that the path of the drop took the form of a saw tooth across the field of view; and from a study of the photograph of the drop the position of best focus could be ascertained. It was also possible to repeat the process by displacing slightly the air in the apparatus, so that the drop was brought back to its original plane. The magnification of the camera was corrected for emulsion shift. Fig. 1 shows the path taken by an oil drop. The wavy sections of the path correspond to the small translation of the drop made to bring it back into focus.

In addition to the effect of the hole on the electric field between the plates, several other factors have been found to influence the experimental value of $e^{2/3}/\eta_{23}$ and are summarized here.

(1) *Purity of the air.* Measurements must be made soon after the admission of fresh air. With air which had been in the apparatus for several weeks, a value of $e^{2/3}/\eta_{23}$ was obtained which was consistently 0·3 per cent higher than that obtained with fresh air. This effect was attributed to impurities coming from the walls of the apparatus and contaminating the air.

(2) *Correction for the walls.* The correction to Stokes's equation due to the influence of the walls of the apparatus increases considerably the value of $e^{2/3}/\eta_{23}$ of some of the previous workers. An auxiliary experiment was carried out[7] which confirmed the Lorentz formula for the effect of a single wall on the motion of a falling oil drop.

(3) *Oxidation of the oil.* Results using Apiezon oil B and castor oil confirmed the conclusion of Ishida *et al.*[4] that oxidation or absorption occurs with oil in the form of very small drops. It was observed that using these oils the downward velocity of the drop when under the action of gravity increased gradually with time, whereas the upward velocity due to the combined action of the gravitational and electrical fields showed a decrease. Fortunately, the variations in these velocities tend to cancel each other in the determination of $e^{2/3}/\eta_{23}$, but a serious error might occur if a drop is studied for long periods after spraying. This effect could not be detected with butyl sebacate, and this oil was used for the determination. Fig. 2 shows the variation of velocities with time of two drops of Apiezon oil B (measurements for Fig. 2 B were taken from the drop photographed in Fig. 1), one drop of castor oil and one of butyl sebacate.

(4) *Impurities in the oil.* Erratic results occurred occasionally if the steel wire brush used for producing the oil drops was nearly dry. This was attributed to impurities in the oil. Some drops have been photographed which showed definite fluctuations in light intensity, due, it is believed, to small steel particles held in the drop. To reduce the possibility of impurities influencing the results, the brush was cleaned regularly and impregnated with fresh oil.

Fig. 1. Path of Apiezon B oil drop ($n = 22$ (electrons), $a = 3{\cdot}90\ \mu$) which had been refocused several times. The wavy sections correspond to the small translation of the drop made to bring it into focus

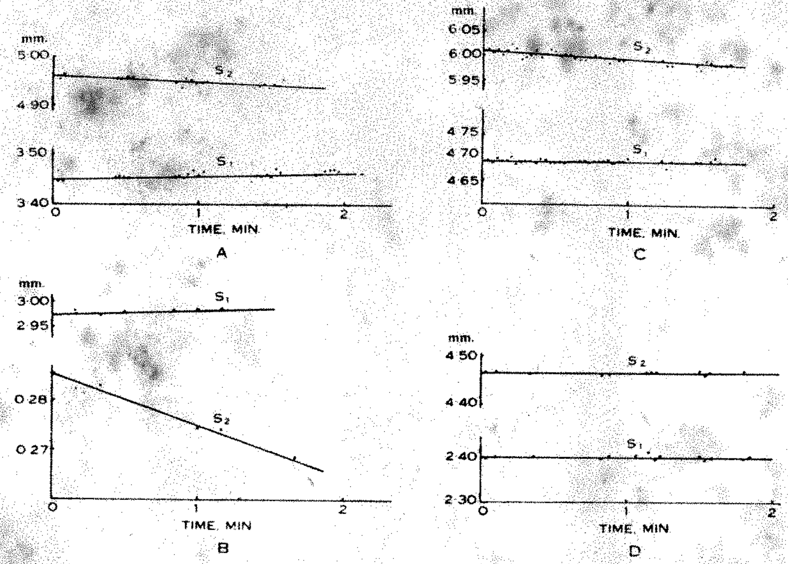

Fig. 2. Variation of drop velocity with time: (*A*) Apiezon oil *B*; (*B*) Apiezon oil *B*; (*C*) castor oil; (*D*) butyl sebacate. S_1 is proportional to the velocity of the drop when under the action of gravity; S_2 is proportional to the velocity of the drop when under the combined action of the gravitational and electric fields

Some of the above factors make marked changes in the values of $e^{2/3}/\eta_{23}$ previously quoted. The result of Bäcklin and Flemberg[3], namely, $334{\cdot}12 \times 10^{-5}$, which was the only one giving a value of $e^{2/3}/\eta_{23}$ agreeing with both the X-ray value of the electronic charge and Kellström's value ($1835{\cdot}0 \times 10^{-7}$ C.G.S.) for the viscosity of air at 23° C., is increased by the correction for the walls to $335{\cdot}03 \times 10^{-5}$. As no data were given regarding the size of the hole used in these experiments, the correction for this cannot be calculated; but it has been estimated that had a hole 0·6 mm. in diameter been used and measurements made below its centre, the above value of $e^{2/3}/\eta_{23}$ must be increased to $335{\cdot}9 \times 10^{-5}$. Following the criticism by Birge[2], the result of Hopper and Laby[5] has been recalculated. Using the same method of analysis for both the castor oil drops and the Apiezon oil *B* drops, the value of $e^{2/3}/\eta_{23} = 335{\cdot}13 \times 10^{-5}$ is obtained, whereas for the Apiezon oil *B* results alone the value is $335{\cdot}40 \times 10^{-5}$. The correction for the wall effect is uncertain, since in that experiment the plates were vertical, but it will increase these values by at least 3 parts in 1,000. (The actual correction may, however, be less than this as the purity of the air may be open to question.) Ishida *et al.*[4] were the only workers to make corrections for the change in density of the oil, and their value corrected for the effect of the walls becomes $336{\cdot}95 \times 10^{-5}$. A correction was necessary to this work owing to an error in voltage measurements[8]. From a recent private communication Prof. Ishida states that this correction, which was determined much later, was found to be as much as $-1{\cdot}1$ per cent. The experiment has been repeated by Ishida, Suetsugu and Matsui, giving, it is stated, $e = 4{\cdot}794 \times 10^{-10}$ E.S.U. ($\eta_{23} = 1{,}830 \times 10^{-7}$ C.G.S.), whence $e^{2/3}/\eta_{23} = 334{\cdot}72 \times 10^{-5}$. If the same correction for the walls is assumed for this as for the 1937 work, the value will be increased slightly to $335{\cdot}02 \times 10^{-5}$. Millikan's value will be increased slightly to $335{\cdot}10 \times 10^{-5}$ if the wall correction is applied. There is internal evidence in this work of a gradual variation in density of the oil, but a correction for this was not made.

In the present investigation, from measurements of forty-seven drops using voltages of 4,000 and 2,000, and for values of $1/pa$ ranging from 21·2 to 174·4, the value of $e^{2/3}/\eta_{23} = (335{\cdot}75 \pm 0{\cdot}11) \times 10^{-5}$ was obtained. Fifty-one values of $e_1^{2/3}/\eta_{23}$ (that is, values of $e^{2/3}/\eta_{23}$ uncorrected for the slip term[1]) from these forty-seven drops are plotted against $1/pa$ in Fig. 3. The value of $e^{2/3}/\eta_{23}$ corresponds to $1/pa = 0$ and will be increased slightly if Oseen's[9] modification to Stokes's analysis is applied, but the increase will be less than + 0·04 per cent.

A summary of the results of several careful determinations of the viscosity of air made since 1913 is given in the accompanying table. Derived values of η_{23} obtained from the corrected oil-drop values of $e^{2/3}/\eta_{23}$ (assuming $e = 4{\cdot}8024 \times 10^{-10}$ E.S.U.) are also tabulated. There is a wide variation between recently determined values of the viscosity, four of those tabulated being close to $1834{\cdot}2 \times 10^{-7}$ C.G.S. and the remaining two being close to $1829{\cdot}5 \times 10^{-7}$. The value adopted by Millikan for his 1917 work was $1822{\cdot}7 \times 10^{-7}$ C.G.S. The present investigation implies a value of $1826{\cdot}5 \times 10^{-7}$ C.G.S. if $e = 4{\cdot}8024 \times 10^{-10}$ E.S.U. is assumed for the electronic charge.

There is reason to believe that the electrical and mechanical measurements involved in the determination of the electronic charge by the falling drop method can be made with sufficient accuracy. The difficulties inherent in the measurement of the viscosity of air represent a greater limitation to the reliability of the method.

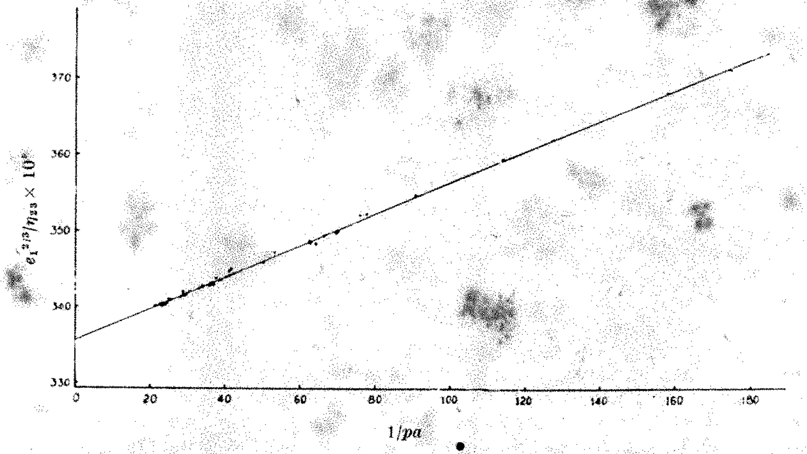

Fig. 3. Fifty-one values of $e_1^{2/3}/\eta_{23}$ (butyl sebacate drops) plotted against $1/pa$.

Viscosity of air at 23° C.

Author	Date	Method	Comments	$\eta_{23} \times 10^7$	Claimed uncertainty* $\times 10^7$	Reference
Gilchrist	1913	R.C.		1825·6	3·6	10
Rapp	1913	C.F.		1823·1	1·8	11
Markwell	1916	C.F.	Repeat of Rapp experiment	1827·3		12
Harrington	1916	R.C.	Same apparatus as Gilchrist	1822·6	1·8	13
Kellström	1937	R.C.		1835·0	3·0	2
Houston	1937	R.C.	Apparatus designed by Millikan and Day	1829·13	4·5	2
Bond	1937	C.F.		1834·34	0·8	2
Rigden	1938	C.F.	Completion of Bond's preliminary investigation	1829·96	0·7	2
Banerjea and Plattanaik	1938	C.F.		1833·75	2·2	2
Bearden	1939	R.C.		1833·79	0·06	2
				Derived values		
Millikan	1917	F.D.	No allowance made for slight density variation	1830·0	1·2	1
Bäcklin and Flemberg	1936	F.D.	Small apparatus. Correction for hole uncertain and likely to be important	$<$1830·4		3
Ishida, Fukushima and Suetsugu	1937	F.D.	Similar apparatus to Millikan. Corrected for density variation	1820·0	0·8	4
Hopper and Laby	1941	F.D.	Small apparatus. Vertical plates. Wall correction uncertain	$<$1824·6		5
Ishida, Fukushima and Suetsugu	(1948)		Voltage correction applied to their previous result (unpublished)	1833·6		
Ishida, Suetsugu and Matsui	(1948)	F.D.	New determination. Corrected for density variation (unpublished). (Uncorrected for density variation)	1830·4 (1829·2)		
Present investigation	(1948)	F.D.	Small apparatus. A decrease $<0·04$ per cent may be necessary owing to the Oseen correction	1826·5	0·6	

R.C. Rotating cylinder method.
C.F. Capillary flow method.
(Viscosities have been corrected for temperature using Sutherland's formula.)
F.D. Falling drop method, assuming $e = 4·8024 \times 10^{-10}$ E.S.U. (see ref. 14).
* Inconsistent methods of estimation of errors used.

Miss A. Grant assisted in many of the measurements and in computing the results. I am also indebted to Prof. L. H. Martin for many helpful discussions during the course of this investigation, details of which will be published in the *Australian Journal of Scientific Research*.

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ACTION OF SURAMIN ON ENZYMES

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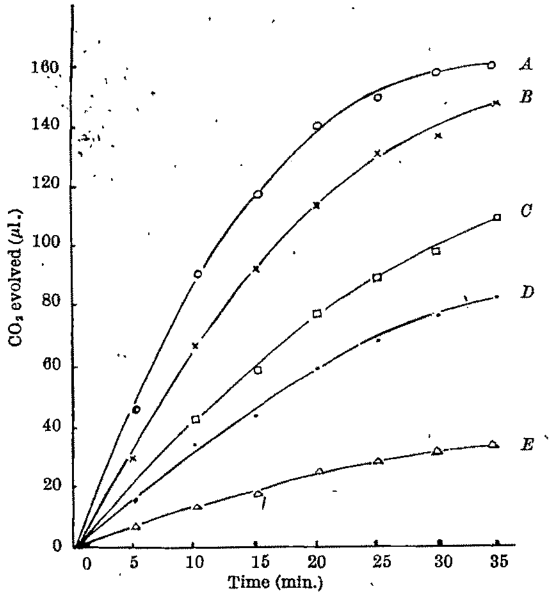
WHEN injected intravenously, suramin (synonyms: 'Antrypol': Bayer 205; 'Germanin': Fourneau 309) quickly effects the removal of trypanosomes from the blood and tissues of man and other animals suffering from sleeping sickness due to *Trypanosoma gambiense* or *T. rhodesiense* infections, if the infection is not too far advanced. The precise way in which suramin exerts its specific action on the trypanosome or on the defence mechanisms of the host or on both is still unknown, although several theories have been advanced[1].

One possible explanation is that the drug combines with or otherwise inhibits enzymes in the trypanosome which are necessary for the normal metabolic changes in that organism. Trypanosomes consume considerable quantities of carbohydrates; it was found, for example, that trypanosomes can be kept alive *in vitro* much longer if glucose is added to the medium[2]. The rapid utilization of oxygen by the trypanosomes can easily be demonstrated by manometric methods, or more simply by keeping small samples of citrated blood from infected sleeping sickness patients and suitable controls out of contact with oxygen for a short time; the trypanosome-containing blood often becomes noticeably darker than the controls, owing to deoxygenation of the oxyhæmoglobin by the trypanosomes.

Any inhibition of this comparatively vigorous oxidative metabolism in the trypanosome might be expected to reduce its reproductive capacity and/or its resistance to the attack of the body defence mechanisms, and a knowledge of the action of trypanocidal drugs on enzymes might prove very useful. We are therefore studying the action of suramin on various enzyme systems, including those of the trypanosome, to determine whether concentrations of the drug similar to those reached in the blood of injected animals, or inside the trypanosome, are likely to prove toxic to any particular enzymes. So far we have largely confined our tests to the yeast enzymes concerned with carbohydrate metabolism and some other enzymes selected for particular reasons.

Previous investigators have studied the action of suramin on a few enzymes. In relatively high concentrations (0·007 *M*, that is, 1 per cent) the drug inhibits trypsin[3], and in $1·75 \times 10^{-4}$ *M* concentrations it was found to be toxic to the enzyme fumarase but not to urease[4]. Acceleration of post-mortem lactic acid production in muscle and liver has been reported[5], but retardation of blood glucolysis[6]. Hyaluronidase

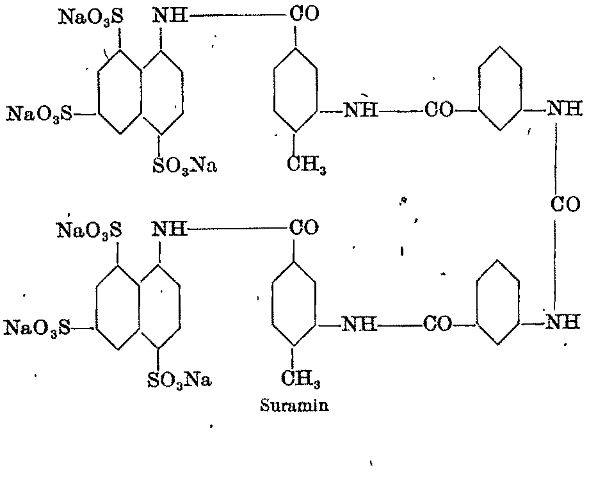


Inhibition of urease by suramin at pH 5·0. (Soya bean urease: 2·3 × 10^{-3} M urea; enzyme and drug in contact for 30 min. before suramin added)

A, no suramin; *D*, *M*/5,000 suramin
B, *M*/15,000 suramin *E*, *M*/3,000 „
C, *M*/7,500 „

has very recently[7] been found to be remarkably sensitive to the drug; 85 per cent inhibition of the enzyme is effected by 7 × 10^{-5} M suramin and 15 per cent by 7 × 10^{-7} M.

In our experiments we have found that although suramin has no inhibitory action on urease at pH 7·5 (thus confirming previous work[4]), marked inhibition occurs at pH 5; at this latter pH a final concentration of 3·3 × 10^{-4} M suramin gives 90 per cent inhibition, and 7 × 10^{-5} M suramin inhibits to the extent of 25–65 per cent (varying with the time of contact of drug and enzyme). A few typical results of these experiments are shown in the accompanying graph. The mechanism of this inhibition is still under investigation; but our results suggest that the suramin acts by competitive inhibition. This may be related to the presence of a urea structure in suramin, but it is also possible that the action of the drug on urease and other enzymes, like the combination with serum and other proteins[8], and the persistence of the drug in the animal body[9], is largely determined by the sulphonic acid groups of suramin.



Suramin

Very recently we learned that Dr. Madinaveiti of Imperial Chemical Industries, Ltd., has also bee carrying out investigations with suramin and ureas and that he has obtained results similar to our ow

Suramin combines with a variety of protein[1] particularly at pH 5 or in more acid solutions[8]. might be expected, therefore, that most enzym would be inhibited by suramin in acid solution, bu this is not so. The hydrolysis of plasma proteins b pepsin at pH 2 is not inhibited by 0·001 M suramin the fact that in precisely the same buffer solution pH 5 urease is strongly inhibited by suramin, wheres invertase is unaffected by the drug, is indicative the specificity of the inhibition. Furthermore, w have found that there are many enzymes which a not significantly inhibited by suramin.

In our experiments, trypsin (Harrington Bros Ltd.) has been found to be much more sensitive t the drug than was previously[3] reported; for exampl 0·001 M concentrations of suramin gave 30 per ce inhibition of the hydrolysis of casein, and 0·0005 M suramin gave 20 per cent inhibition at pH 8·9 and 30 Inhibition of this enzyme may be due to the similarit between the —NH—CO—NH— structure of surami and the peptide linkage of proteins, but further wor will be needed before this is fully established. Test are now being carried out to determine the effect, o urease, trypsin and other enzymes, of several surami analogues and similar compounds.

Since the metabolism of trypanosomes is largel concerned with carbohydrates, we decided to study by manometric methods, the action of suramin o the carbohydrate-metabolizing enzymes of yeast We have found that the drug strongly inhibits th fermentation of glucose by yeast juice, concentration greater than 2·0 × 10^{-5} M giving 100 per cen inhibition. This concentration is considerably les than that which is maintained in the plasma of rabbit for several hours or days after the injection o an amount of the drug equivalent to that use clinically; even after four days, for example, th level may still be 3·5 mgm. of suramin/100 ml. o plasma (equivalent to 2·5 × 10^{-6} M)[11]. Our stud of the effect of the drug on the individual enzyme of yeast is not yet complete, but it is hoped that i will provide a clue to the enzymes in the trypanosom which are likely to be affected by the drug.

We are grateful to the Medical Research Counci for a grant covering the expenses of these investigations. Thanks are also tendered to Dr. M. Dixo for samples of fructose diphosphate and adenosin triphosphate, to Dr. A. Spinks (of Imperial Chemica Industries, Ltd.) for samples of several suramin analogues, and to Miss Barbara Hume for help wit some of the manometric experiments.

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DENSITY OF HEAVY WATER

By PROF. TSING-LIEN CHANG

AND

LÜ-HO TUNG

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THE density of heavy water was accurately determined by Stokland, Ronaess and Tronstad[1] n the temperature range 10–27°. Measurements ere extended to 50° by Chang and Chien[2], and later y Wirtz[3]. Recently, we have further extended the measurement up to the boiling point of heavy water.

A 16-ml. quartz pycnometer consisting of a bulb ith a short stem of 0·5-mm. calibre and a ground-oint cap was used. A thermostat kept the temperature constant within 0·01°. Special precautions were aken regarding the pycnometry, thermometry, urification of water, avoidance of contact with tmospheric moisture, reduction of the weighings to acuum, and volume correction for the thermal xpansion of vitreous quartz. In order to make sure f the accuracy of our measurements, we have etermined the density of ordinary water between 0° and 100° and found that the results agree with hiessen's data[4] within three units in the fifth ecimal place.

Two ampoules of heavy water of different conentrations supplied by Norsk Hydro-Elektrisk vaelstof A/S were distilled under vacuum direct nto the pycnometer. The mole percentage of D_2O as calculated[5] from its density ratio d_{25}^{25} in comparon with ordinary water at 25°. The Norwegian eavy water is known[6] to contain 0·32 weight per ent D_2O^{18}. Three series of measurements were arried out on samples containing 99·71–99·77 mol. er cent D_2O at intervals of 5° between 25° and 00° with special attention to the temperature range bove 50°. The density ratio d_{25}^{25} of the sample was etermined before and after each series of measurements.

From the density values so obtained are subtracted hose of ordinary water at the corresponding temperatures. The difference of density between heavy ater and ordinary water is obtained by linear xtrapolation. In the extrapolation to 100 per cent H_2O with normal isotopic composition of oxygen, the xcess of the oxygen-18 water is included in the D_2O ontent. The possible error so introduced will not ffect the fifth decimal place of the density value.

The density differences at various temperatures ere smoothed by the graphical method. The mean eviation of the measured values from those of the moothed curve is 0·000 02 gm./ml. Using Swift's alue[5] for 5° and Tronstad's values[1] between 10° and 5°, we have prepared the accompanying table for he density of heavy water (d_{D_2O}) in the liquid state, overing the complete temperature range between its eezing and boiling point. Considering the errors om different sources, we believe that our density alues are accurate to 0·000 05 gm./ml. The density f ordinary water (d_{H_2O}) is also given for comparison, ogether with the density ratio of heavy and ordinary ater. This ratio has also a tendency to pass over a maximum as predicted by Chang and Chien. The emperature for such a maximum seems to lie not far bove the boiling point.

Temperature °C.	d_{H_2O} gm./ml.	d_{D_2O} gm./ml.	$d_{D_2O} - d_{H_2O}$ gm./ml.	$\frac{d_{D_2O}}{d_{H_2O}}$
3·8	1·00000	1·10538	0·10538	1·10538
5	0·99999	10555	556	556
10	9973	10595	622	625
11·2	9961	10596	635	639
15	9913	10583	670	678
20	9823	10530	707	726
25	9707	10440	733	764
30	9568	10319	751	798
35	9406	10169	763	827
40	9226	09992	767	851
45	9024	9790	766	871
50	8807	9565	758	888
55	8573	9319	746	902
60	8324	9054	730	913
65	8059	8771	712	924
70	7781	8471	690	933
75	7489	8154	665	940
80	7183	7821	638	946
85	6865	7472	607	950
90	6534	7109	575	954
95	6192	6732	540	957
100	5838	6342	504	960
101·4	5736	6229	493	960

The density values in the temperature range between 30° and 50° formerly determined in this laboratory[2] are slightly too high, and those of Wirtz too low, while Bridgman's approximate values[7] for 60° and 80°, which represent the only known data above 50° up to the present, are much too high.

Experimental details will appear elsewhere.

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MATHEMATICAL ASSOCIATION

ANNUAL MEETING

FOR the first time, the annual meeting of the Mathematical Association was held outside London; at the invitation of the Association's Midland Branch, and with the generous co-operation of the University of Birmingham, which provided lecture theatres and hostel accommodation, the Association met at Birmingham during April 20–23.

Duties abroad prevented the president, Sir Harold Spencer Jones, Astronomer Royal, from attending the meetings. In his absence, Mr. A. W. Siddons presided over the business meeting on April 21, at which Mr. A. Robson, until recently senior mathematical master at Marlborough College, was elected president for the forthcoming year. Sir Harold Spencer Jones will give his presidential address next year, Mr. Robson having agreed to give his address this year to fill the gap. Under the title, "How they Learnt, 1600–1850", Mr. Robson traced the development in content and treatment of the mathematical curriculum in English schools during this period, based on a study of text-books and school records, particularly those relating to Christ's Hospital. Mr. Robson's investigations show that the common view that mathematics was taught entirely as an academic subject, with little relation to practical applications, is not wholly correct. Prof. S. Brodetsky, formerly of the University of Leeds, then gave a lecture on nomography, showing how the solution of equations and the performance of various types of calculation can be carried out rapidly and with reasonable accuracy by means of the alignment of points on scale-carrying lines. For the remainder of April 21, a programme of excursions and entertainment was provided.

The morning of April 22 was occupied with two lectures: Dr. W. M. Hampton outlined the mathematical investigations which have been made into certain practical problems in glass-working, showing a very fair correspondence between theory and practice. Prof. R. Peierls, of the University of Birmingham, spoke on "Mathematics—Dead or Alive ?", and emphasized a principle which has always been fundamental in the Association's policy, that mathematics cannot successfully be taught as a dead subject, but only as a living organism in contact with present-day developments, whether these be in the applications of mathematics to problems of importance in other sciences or in the extension of mathematical knowledge itself by current research.

Two valuable discussions filled the afternoon session. In opening the discussion on "A Realistic View of Main School Geometry", Mr. C. V. Durell proclaimed that geometry is a physical science, not a pattern of logical relations between mathematical abstractions ; but Mr. Robson, following Mr. Durell, maintained that a logical system of some kind must be developed in the later years of the school geometry course. In the following open discussion, there appeared to be some feeling among the younger teachers that the reaction against Euclid in the schools may be in danger of going too far. The other discussion, on "Alternatives to School Certificate Mathematics, with reference to Secondary Modern Schools", opened by Mrs. E. M. Williams (City of Leicester Training College) and Mr. R. C. Lyness, a Ministry of Education inspector, reflected the Association's close attention to the problem of mathematical teaching in the new Modern School, where there is a danger that content and method may be too closely a copy of content and method in the Grammar School, instead of being firmly based and developed on the functional needs of the Modern School.

In the evening, Mr. J. A. Petch, secretary of the Joint Matriculation Board, spoke on a subject of vital interest to teachers, "Statistical Treatment of Examination Marks". Mr. Petch described the mathematical methods used in dealing with large-scale external examinations in order to minimize variations, to standardize the markings of a panel of examiners who share the assessment of scripts in one subject, and to set up a standard of comparison between markings in different subjects. His audience welcomed his demonstration of the skill, care and patience devoted to the assessment of the merits of the School Certificate candidate.

On the morning of April 23, a first step was made on a programme which the Association hopes to follow up in later meetings, by getting speakers from outside Great Britain to deal with aspects of mathematical education in their countries. On this occasion, Mr. B. T. Gilroy, of New South Wales, and Mr. R. G. Keats, of South Australia, outlined the system of mathematical teaching in the secondary schools and universities of Australia. Dr. H. C. Christofferson, of Oxford, Ohio, described the ideals which inspire the teachers of mathematics in the high schools of the United States ; members of the Association supported his plea for a complete fusion of theory with practice, appreciated his illustrations of detail, and relished his fund of American anecdote.

A NEW FOSSIL GYMNOSPERMOU 'OVARY'

THE discovery of a new type of many-seede fruit body from the Lower Carboniferous Scotland is a matter of more than local palæobotanic interest. The publication by Prof. John Walton the full description of *Calathospermum scoticu* (*Trans. Roy. Soc. Edin.*, 61, 719 ; 1949), which h been awaited since the preliminary account in 1940 is therefore most welcome, although it is difficult withhold a protest that any learned society, so lo after the end of the War, should subject importa scientific work to the treatment recorded in t superscription "MS. received May 10th, 1947. Re May 3rd, 1948. Issued separately Feb. 11th, 1949

Calathospermum scoticum consists of isolated fru bodies of large size (up to 24 mm. × 45 mm.), shap like a tulip and each consisting of a cupule divid into six segments which surround either a centr mass of stalks or an equivalent number of stalk ovules. Compared with other known many-seed cupules (*Gnetopsis* and *Calathiops*), *Calathospermu* is the first to be discovered of Palæozoic age in whi the mode of arrangement of the ovules inside t cupule can be studied, thereby contributing son very interesting comparative facts to place beside t better known but much more recent *Caytonia*. T stalks in *Calathospermum* are partly borne on t margins of the cupule segments but also on a quad partite central column to which some twenty-four them may be attached. Each stalk has a centr vascular strand which is continued into the integ ment of the ovule and out into its appendages. T latter consist of nine terete apical projections considerable length which terminate the orthotropo ovules. In the form of these appendages and in oth characters the ovules themselves resemble ve closely those of *Salpingostoma dasi* described b Gordon in 1941[2], although they are thought to b specifically distinct. *Salpingostoma*, interesting enough, is itself the oldest structurally preserv seed which can be assigned with certainty to t Pteridosperms.

In attempting to interpret the presence of tw states of the fruit bodies, those containing ovules o badly preserved (and therefore perhaps immatur stalks and those containing well-preserved stalks b no ovules, the suggestion is made that the latter a probably in the more advanced developmental stat It is thought that, as the seeds ripened, their stal may have elongated and extruded them from t cupule, after which they became detached. Fro details observed in the histology of the cupule se ments it is thought that these may have opened o in a perianth-like manner during extrusion of t seeds, although in the water-logged condition pr ceding fossilization they had again closed.

The fruit body appears to have been borne on t end of a stalk containing a single crescentic vascul strand. It is therefore concluded that they we foliar and not axial appendages.

For the non-specialist reader a valuable com mentary on these facts will be found in the recent published Symposium on the Evolution and Class fication of the Gymnosperms held in Chicago i December 1947. Prof. H. N. Andrews's paper[3] i particular supplies a very valuable background i his survey of existing knowledge of Pteridosperms i general, while Prof. B. Sahni[4], by giving details another new Gymnospermous group, the Jurassic Pentoxyleæ, in which naked seeds with fleshy integuments are clustered directly on to a cauline cone axis totally devoid of any trace of leaf-like appendages, provides a wholesome corrective against the hasty generalizations which *Calathospermum* by itself might arouse in the unwary. Both *Calathospermum* and the Pentoxyleæ are, however, of first-rate theoretical importance in the phylogeny of the Gymnosperms, and both, therefore, merit the attention of a general botanist.

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EUROPEAN CORN BORER IN NORTH AMERICA

THE European corn borer (*Pyrausta nubilalis*) was first found in the United States in 1917, among sweet corn near Boston, Mass., where it was infesting an area of at least 100 square miles. It was later found that the insect was also present at the same time near St. Thomas, Ontario. The actual date or year of entry of this dangerous pest into North America is uncertain, but circumstantial evidence points to its occurrence among broom-corn imported from Hungary or Italy between 1909 and 1914.

The insect is among the most threatening of all pests of Indian corn (or maize); accumulated knowledge shows that its eradication is not possible, but various cultural practices can be adopted so that there results a reduction in the losses caused by the insect. According to W. A. Baker and W. G. Bradley, entomologists of the U.S. Bureau of Entomology and Plant Quarantine, the damage caused by the borer in the United States in 1945 was estimated at 36,700,000 dollars. In a recent publication by these two entomologists* they state that infested areas extend all down the east coast and across the continent to districts west of the Great Lakes. The favourite plant host in America, as in Europe, is Indian corn (maize), but the insect also attacks beans, soybean, millet, oats, potatoes and some other cultivated crops. Garden flowers are also infested, notably dahlias, gladioli, zinnias, chrysanthemums and various weeds that grow among or bordering the maize crop. Among the Lakes States the corn borer is single-brooded and feeds almost entirely on maize, whereas in the southern and eastern parts of the infested region two or even three broods prevail, and the insects affect a wide range of different plants. The injuries it causes are effected during the larval stages when it tunnels into the stalk, main stem or mid-rib of its host-plant, as the case may be. As a result of the damage thus caused, much of the nutriment is cut off from the ear or flowering part, which weakens or flags and breaks.

As regards methods of controlling the borer, the indigenous insect parasites have proved of no avail. They number twenty-four different species, yet their combined activities have resulted in the destruction of only a fraction of 1 per cent of the borer. Large numbers of foreign parasites have been introduced from Europe and have established themselves, but it is premature to state whether they will prove to be effective controlling agents. At the present time the corn borer can be best controlled by utilizing or destroying all parts of infested plants before any of the insects they may contain are able to change into the adult or moth stage. Feeding affected crops to livestock either directly from the field or as silage is a valuable method. In other cases deep ploughing beneath the soil or complete burning of all infested vegetation before the spring when the moths appear is recommended. Any method that leaves behind living borer caterpillars among the plant residues merely provides for the infestation to go on during the following year. The use of insecticidal sprays containing D.D.T. or other toxic agents has been recommended for use during the period when the eggs are hatching, in order to destroy the young caterpillars.

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* U.S. Department of Agriculture. Farmers' Bulletin No. 1548: The European Corn Borer; its Present Status and Methods of Control. Revised edition, by W. A. Baker and W. G. Bradley. Pp. 46. (Washington, D.C.: Government Printing Office, 1948.) 15 cents.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, May 9

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. S. W. Wooldridge and Mr. S. H. Beaver: "Land Use and Surface Mineral Working in Britain".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. J. Cole: "Aspects of Biological Discovery, 2, Circulation of the Blood".*

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Graphical Methods in Teaching Electrical Engineering (including Radio)" (to be opened by Mr. S. N. Ray).

Tuesday, May 10

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Tom Harrisson: "Human Studies in Central Borneo, 1945–49".

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. D. V. Glass: "The Application of Social Research" (Inaugural Lecture).*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. Barr and Mr. J. Erskine: "The Manufacture and Use of Stainless-Clad Steel".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. Jacques Tréfouël (Paris): "Some Advances in Chemotherapeutic Research at the Pasteur Institute".*

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Annual General Meeting; at 6.30 p.m.—An Address by Monsieur L. Gaymard.

Wednesday, May 11

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 11 a.m.—Conference on "Combined Heat and Power Supplies".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Robert Broom, F.R.S.: "South Africa's Contribution to our Knowledge of Man's Evolution".

Universities Federation for Animal Welfare (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. Jean-Paul Harroy: "Nature Protection".*

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. F. Morton: "Examination of Crude Oils in relation to Geological Formations".

Physical Society, Low Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Discussion on "The Use of Thermodynamic Diagrams in Industry" (to be opened by Prof. D. M. Newitt, F.R.S.).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "How Crystals Grow".

Thursday, May 12

Council for the Preservation of Rural England (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. H. Raistrick, F.R.S.: "A Region of Biosynthesis" (Bakerian Lecture).

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

University of London (in the Great Hall, King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. V. Gordon Childe: "Social Worlds of Knowledge" (Hobhouse Memorial Lecture).*

Chemical Society, Hull Branch (joint meeting with the University College Scientific Society, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. A. R. Todd, F.R.S.: "The Mechanism of Drug Action".

Chemical Society (at the Royal Institution, Albemarle Street, London, W.1), at 7.15 p.m.—Dr. E. Lederer: "The Chemistry and Biochemistry of some Mammalian Secretions and Excretions".

Friday, May 13

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Eighth Annual General Meeting; at 3.15 p.m.—Mr. C. E. Coulman and Mr. G. R. Petrie: "Notes on the Designing of Aspherical Magnifiers for Binocular Vision"; Lecture by Monsieur André Maréchal.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

University of London (at the Senate House, London, W.C.1), at 5.30 p.m.—Prof. A. C. Pigou: "Wage Statistics and Wage Policy" (Stamp Memorial Lecture).*

Saturday, May 14

British Psychological Society, Social Psychology Section (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 3 p.m.—Mr. M. D. Vernon: "The Significance of the Individual in the Social Group".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Experimental Officers at the Atomic Energy Research Establishment, Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2529 (May 13).

Physicist—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (May 14).

Senior Assistant in the Department of Civil and Mechanical Engineering, a Senior Assistant in the Electrical Engineering Department, and a Senior Assistant in the Department of Applied Chemistry—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1 (May 14).

Teacher of Electrical Engineering, a Teacher of Physics, and a Teacher of Building and Structural Design—The Principal, College of Technology, Belfast (May 14).

Senior Assistant to teach Civil and Mechanical Engineering subjects to Honours Degree standard—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 14).

Lecturer in Physics and Physical Chemistry at Birkenhead Technical College—The Director of Education, Education Offices, 63 Hamilton Square, Birkenhead (May 14).

Lecturer in the Department of Chemistry, and a Lecturer in the Department of Physics and Mathematics, Liverpool College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (May 14).

Regional Director in the County Extension and Advisory Service of the College, an Assistant County Organiser, an Assistant Lecturer in Agricultural Engineering and Surveying, and a Lecturer in Horticulture—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (May 15).

Scientific Officer (Chemist) in the Food Infestation Control Section in Glasgow of the Department of Agriculture for Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.271/49A (May 16).

Electrical Engineer (Third Assistant grade), an Electrical Engineer (General Assistant grade), a Mechanical Engineer (Second Assistant grade), a Physicist (Second Assistant grade), a Physicist (General Assistant grade), and a Chemist (Second Assistant grade), in the Laboratory at Leatherhead—The Director of Establishments, British Electricity House, Great Portland Street, London, W.1 (May 16).

Principal Scientific Officer to control research and development of radio and radar navigation devices and aircraft approach and landing aids, a Principal Scientific Officer to control research and development of radio communication systems, etc., and a Senior Scientific Officer for the development of components for new radio equipments, in the Ministry of Supply, London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2520 (May 18).

Research Assistant (Grade II) in the Library—The Director and Secretary, Science Museum, South Kensington, London, S.W.7 (May 21).

Lecturer and an Assistant Lecturer in Geology—The Registrar, University College, Singleton Park, Swansea (May 28).

Entomologist to the West Indies Cacao Research Scheme, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (May 28).

Research Officer—Heat Laboratory (Ref. No. 1918), and a Research Officer—Wool Research Laboratory (Ref. No. 1919), in the Division of Physics, Council for Scientific and Industrial Research, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 28).

Lecturer in Zoology, and an Assistant Naturalist in the Dove Marine Laboratory—The Registrar, King's College, Newcastle-upon-Tyne (May 28).

Lecturer in Electronics—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (May 30).

Graduates (preferably those who have taken Mathematics or Physics to an advanced stage) for Junior and Senior positions in the New Zealand Meteorological Service—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (May 30).

Lewis Cameron Fellow and Lecturer in the Department of Bacteriology—The Secretary, The University, South Bridge, Edinburgh 8 (May 31).

Research Assistants (with good honours degree in Physical Chemistry) for work on the physical and chemical aspects of selective flotation, a Lecturer in Mining, and a Lecturer in the Extra-Mural and Social Studies Department—The Registrar, The University, Leeds 2 (May 31).

Chair of Industrial Metallurgy, and the Second Chair of Chemical Engineering—The Secretary, The University, Birmingham 3 (May 31).

Readership in Physical and Inorganic Chemistry at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 1).

Reader or Senior Lecturer in Economic Geography—The Registrar, The University, Manchester 13 (June 3).

Superintending Anthropologist, Department of Anthropology, Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 446.E (June 11).

Lecturer (Grade II) in Tool Engineering and Metrology, and a Lecturer (Grade II) in Industrial Statistics—The Secretary, The University, Birmingham 3 (June 15).

Tube Investments Research Fellowship in the Department of Engineering Production—The Secretary, The University, Birmingham 3 (June 15).

English Electric Company Bursaries in Hydro-Power Engineering—The Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7 (June 30).

Assistant Professor of Pharmacology in Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (June 30).

Lecturer in Chemistry—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

Departmental or University Demonstrator for Research in Agricultural Production and Farm Organisation, and a Departmental or University Demonstrator for Market Research and Analysis—The Secretary, Agricultural Economics Research Institute, Parks Road, Oxford.

Education Lecturer in the Department of Hygiene and Public Health—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Histological Technician for cancer research work in the Laboratory of the Department of Anatomy—The Secretary and Registrar, The University, Bristol 8.

Lecturer in the Department of Mathematics, and a Senior Assistant Lecturer in the Department of Electrical Engineering and Physics—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Bursaries (3) for research in Physical Chemistry, tenable at the Imperial College of Science and Technology—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Laboratory Technician to assist with a fundamental research programme on the physics of rubber—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Director of the West African Building Research Organisation—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Cérémonies de Xe anniversaire de la mort de Lord Rutherford. Organisées par la Fédération mondiale des travailleurs scientifiques, l'Association française des travailleurs scientifiques, le Syndicat national de l'enseignement supérieur et de la recherche scientifique. Pp. 68+6 plates. (London: World Federation of Scientific Workers, 1947.) [2911

British Standard 522:1948. Orthocresol, Metacresol and Paracresol. Pp. 16. 2*s*. net. British Standard 523:1948. Phenol. Pp. 16. 2*s*. net. British Standard 524:1948. Refined Cresylic Acid. Pp. 20. 2*s*. 6*d*. net. (London: British Standards Institution, 1948.) [2911

Catalogues

Catalogue of New Books on Electrical Engineering, Radio and Electronics. Pp. 24. (London: H. K. Lewis and Co., Ltd., 1948.)

Type 903A Oil Diffusion Pump and Combination Baffle Valve. (Leaflet B/903A/1.) Pp. 4. Edwards (Philips Type) Cold Cathode Ionisation Gauge Model 3. (Leaflet D20/3–1.) Pp. 4. (London: W. Edwards and Co., Ltd., 1948.)

A Catalogue of Books of English Literature and History printed after 1700, together with Books from Modern Presses, etc. (No. 661.) Pp. 76. (London: Bernard Quaritch, Ltd., 1948.) 6*d*.

Marmite Yeast Extract in Medicine and Dietetics. Revised edition. Pp. 16. (London: Marmite Food Extract Co., Ltd., 1948.)

A Catalogue of Books on Archæology and Folklore, Arts and Crafts, History, Naval History and Shipping, Sport, Music and Theatre, etc. (No. 694.) Pp. 122 (London: Francis Edwards, Ltd., 1948.)

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FUNCTIONS OF A UNIVERSITY

THE efforts of the United Nations Educational, Scientific and Cultural Organisation during the last two years to promote educational reconstruction in Europe have in recent months assumed fresh importance, and indeed they have been strengthened. As the European recovery programme progresses and the project for Western Union takes shape, the key position of Germany in both becomes more manifest, from the point of view of defence and of economic affairs. Moreover, the place which Germany takes in the new Europe depends not only on the structure of Europe itself but also on the character of the new Germany.

In the shaping of that new Germany, the German universities have a decisive part to play. A new Germany responsive to the tradition of Western Europe, and able to take her place in a partnership of democratic peoples, can only follow from a fuller understanding of that tradition and of the nature of democracy, and the efforts of leaders inspired by a respect for intellectual freedom and for individual personality which was so conspicuously absent under the Nazi regime. If the universities of Germany are to provide such leaders and to make their essential contribution to the re-education of Germany, they have to purge themselves from the debased standards introduced under the Nazi regime and to restore the old tradition of scholarship and respect for truth and freedom of inquiry.

The shock which the academic world as a whole received through the surrender by the German universities of their *Lehrfreiheit* under a totalitarian regime and their failure to defend with any vigour their right to independence of thought, investigation and utterance—all the more remarkable because of the German idea of a university as a place devoted primarily to the pursuit of knowledge—led directly to the formation of the Society for the Protection of Science and Learning. The activities of this body, with the war-time conferences of the Association of University Professors and Lecturers of the Allied Countries in Great Britain and the Conference of Allied Ministers of Education, had an important influence in the formation of the United Nations Educational, Scientific and Cultural Organisation itself. These movements have stimulated much wider general concern with another function of a university, to which the Germans paid little attention, namely, that of instilling the culture of a society into its future leaders.

Great Britain, through its responsibility for one of the Zones of Occupation in Germany, has a special interest in the extent to which the German universities can contribute to the democratic development of the German nation. At the beginning of the Allied occupation, the British hoped that the universities would be one of the architects in shaping the new German society. It was early recognized, moreover, that that contribution could only be made after a drastic reform of the universities, and not merely after they had been purged of the Nazi elements which had debased their standards. Something much more than mere repair or physical reconstruction was required.

The task of reform is essentially a matter for the German people themselves: it cannot be imposed from without. The Occupation Authorities must, however, bear some large measure of responsibility for providing the conditions in which reform and reconstruction are possible. That was essentially the purpose of the Commission set up by the British Military Governor in the spring of 1948, although it was concerned directly only with the universities and technical colleges in the British Zone. It was not to be concerned with the present plight of German universities, their ruined buildings, their destroyed libraries, their lost endowments and the poverty of their students. It was solely concerned with the shape which the Commission hoped the universities might assume in the future. The recommendations of the Commission are thus primarily a matter for the German people. Reform must come from within, and it is the way in which the Commission's report is received in Germany that is of the first importance. Nevertheless, for the reasons already indicated, the report is one well worthy of study by the British universities, as the summary recently published in these columns (*Nature*, April 9, p. 552) shows, while passages in the recent book by Sir Walter Moberly, "The Crisis in the University", further emphasize its relevance to the supernational character which to some extent every true university must possess. As Sir Walter says rightly, university people recognize ties and obligations which transcend national frontiers and are not to be dissolved or suspended by the fiat of any national government: "For the due performance of its function the university must be recognized as an independent spiritual organ of the community".

For that reason alone, any reform of the German universities which might enable them in future to offer effective spiritual resistance to doctrines threatening the roots of their independence and functions of teaching and research cannot but be a matter of close concern to free universities everywhere. They will examine the Commission's recommendations with interest and be ready to help at any point where the German universities may seek aid. As Lord Lindsay of Birker, one of the two non-German members of the Commission, has already indicated, the insight into German universities which the report of the Commission gives may well bring fresh inspiration to British universities as they consider anew what should be the ideal and functions of a university in a modern community.

The German universities were at one time justly famous for their freedom and the individuality in research, which, under the influence of von Humboldt, they have encouraged since the early years of the last century. The Commission was rightly concerned whether this ideal of the university as the home of free research was capable of re-adaptation to modern times. If the German universities can regain their tradition of *Lehrfreiheit* and *Lernfreiheit*, it must also be considered whether the isolation of the universities from a great part of the population and of public opinion can be remedied, and whether a finer conception of the relations of teaching and research can be extended to inspire the leaders in social life. These are questions independent of national frontiers, and they are shown as clearly by Sir Walter Moberly as in the Commission's report.

Nor is this all. The Commission not only desires to see the universities brought again into the main currents of German social life; it also visualizes greatly increased facilities for study for students of limited means, in line with the increasing opening of the universities of Great Britain, through the extension of scholarships and awards. Its recommendations for experiment with a 'studium generale' to teach the unity of culture and counteract the dangers of specialization and the divorce of technology from social awareness have much in common with Sir Walter Moberly's observations; and the suggestion for a university council to promote closer relations between the university and all sections of the population is an interesting German adaptation of the constitution of the universities of the British Isles. If this proposal is adopted, its development will be watched with interest, not least in respect of its bearing on the contribution of the universities to the cultural and intellectual life of the surrounding community.

The proposal in the Commission's report for a wider conception of the function of the university teaching staff, which places the teacher alongside the research worker as his fellow, is the biggest departure from the von Humboldt ideal. The suggested new teaching posts, carrying the status and privileges of the traditional scholarly 'Dozent' and 'Professor', give the most emphatic expression to the conception of the function of a university which the Commission enunciates at the start: "to serve mankind by the teaching of that truth which comes from scientific research into reality".

The whole trend of the report is thus in line with the trend of opinion elsewhere regarding the place of the university in the modern world. This report is unanimous, and its proposals well designed to enable the German universities to recover their prestige. Its interest for British readers may cause some to regret that the Commission did not go further into the earlier history of the German universities and trace the reasons for the difference in development of German and British universities, in spite of their similarity of pattern in the Middle Ages. Nevertheless, the report is a real contribution to the studies of universities in the modern world to which Sir Walter Moberly has just made so valuable a contribution in Britain. Although, like Sir Walter, the report says little on the question of numbers in relation to the maintenance or even raising of standards, it shows that the Commission is keenly aware of the grave problem presented by the prevailing current of cynicism among the student population, and not in Germany alone. The new note of wide emphasis on the service of mankind may help to dispel such cynicism and fill that mental and spiritual vacuum. The labours of the Commission should bring new hope and fresh purpose, too, to all those bodies like

German Educational Reconstruction which are experimenting with academic relations between Germany and Britain; there is room for more experiments like the recent Oxford conference of economists and economic administrators from both countries arranged by that body. The free circulation of professional learning is a great safeguard against the atrophy of academic institutions, and a powerful stimulant of those supernational relations which nurture the noblest ideals of university life and work.

INDIAN INDUSTRIAL DEVELOPMENT

The Wealth of India

A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials, Vol. 1. Pp. xxvii+254+39 plates. 15 rupees; 24*s*. Industrial Products, Part 1. Pp. xii+182+8 plates. 8 rupees; 12*s*. (New Delhi: Council of Scientific and Industrial Research, 1948.)

IT may occasion some surprise to those men of science who are ill-acquainted with India, and who so frequently express the view that Governments are unappreciative of the importance of science, to learn that as far back as 1886 the Government of India arranged for Dr. George (later Sir George) Watt, professor of botany in the Presidency College, Calcutta, to prepare a "Dictionary of the Economic Products of India". The six volumes of this standard work were published during the years 1889–99. In 1908 Sir George Watt published a condensed version, "The Commercial Products of India". Whatever the defects of these 'dictionaries', they have been of inestimable value to all interested in Indian natural products.

At the time of their publication, agriculture was the main Indian industry, and there were few others of any substantial size. In fact, prior to the First World War, there were only the textile industries, cotton and jute, since the great Tata Iron and Steel Works, which owed so much to the enthusiasm of the late Sir Thomas Holland, were still in process of erection. The partial isolation of India during the First World War and the demands of the Services, more especially for the Mesopotamia campaign, caused considerable expansion which should have been stimulated by the admirable report of the Indian Industrial Commission. Unfortunately, political dissension and economic difficulties led to the pigeon-holing of its major recommendations. It remained for the repercussions of the Second World War to make India realize once again the urgent necessity of setting up within her own boundaries the basic industries. Of much importance was the realization that this could only be achieved if her scientific man-power was fully mobilized.

For this purpose a Council of Scientific and Industrial Research was constituted with Sir Shanti Bhatnagar as the director of research. Later, this was reconstituted as the Department of Scientific and Industrial Research. In meeting the immediate war-time problems the need for a new edition of Watt's "Dictionary" was naturally felt, and in 1942 an advisory board and editorial staff, with Dr. B. L. Manjunath as the chief editor, was appointed to undertake its preparation.

We have now before us in vol. 1 not merely a new edition of Watt but a completely new work entitled "The Wealth of India: a Dictionary of Indian Raw Materials". The first volume covers subjects *A–B*, and it is anticipated that five further volumes will be published. As is not unnatural, the majority of the 220 articles deal with botanical subjects; but the field which has been covered is remarkably wide. As would be anticipated, the various articles are not of equal merit; but a high standard is maintained throughout, and the articles contain adequate literature references. As an indication of their value, mention may be made of the lengthy account (fifteen pages) on groundnuts, to which so much attention has recently been given. It is somewhat startling to read that on some of the Government research stations in India yields of 1,744 lb. per acre from the rain-fed crop and 3,328 lb. from the irrigated crop have been recorded, while in Madras the average annual yield is 990 lb. per acre. This article is worthy of careful study by those responsible for the growing of groundnuts in British Colonies.

Of interest also, in view of the increasing shortage of pulp suitable for the manufacture of paper, is the article on bamboo. Owing largely to the work of Raitt at the Forest Research Institute, Dehra Dun, where a pilot plant was erected in 1924, the difficulties encountered in using this material were overcome. In 1944–45, 62,300 lb. of bamboo pulp were manufactured in India; but unfortunately the pulp is costly, and it is therefore used in admixture with rag, grass or chemical pulp.

The wide field which is covered by vol. 1 may be indicated by mentioning that even the ornithologist will find much of interest in the article on "Birds".

The book is fully illustrated with many coloured plates, and it is printed on excellent paper, while the price is very reasonable. It reflects the highest credit on the chief editor and his staff. We look forward with pleasure to the appearance of further volumes, which will be indispensable to all who are interested in natural products.

It is somewhat more difficult to understand exactly to whom the volume "Industrial Products" will appeal. According to the introduction, "the primary purpose of the new work should be to secure fuller utilisation of Indian materials by Indian industrial and commercial interests and therefore it should also include Indian industrial products. . . . In the articles on these subjects an attempt is made to trace the development of various industries in India and to describe their present position."

We have, therefore, in this volume articles on such diverse subjects as acetylene, alcohol, alkalis, aluminium, boots and shoes, brass and bronze ware. The accounts are excellent, giving in suitable cases a full description of the chemistry or metallurgy, together with statistics of the present production in India. The articles are accompanied by illustrations of the factories recently erected in India. Apart from their references to Indian conditions, better accounts of many of the industries are to be found elsewhere. Useful as these volumes may prove to be for Indians, we feel that they are likely to have little appeal elsewhere, more especially since much of the information which they contain must very soon be out of date. Like the "Dictionary of Indian Raw Materials", the book is excellently produced.

In conclusion, we should mention that, although these dictionaries are published by the Government of the Dominion of India, we have, for convenience, used the term India in its old connotation, since in general their contents will appeal equally to the two Dominions, India and Pakistan.

J. L. Simonsen

A CAREFUL STUDENT OF HISTORY

The Meaning of Human History

By Morris R. Cohen. (Paul Carus Lectures, Sixth Series, 1944.) Pp. ix+304. (La Salle, Ill.: Open Court Publishing Company, 1947.) 4 dollars.

"It is not well to give an affirmative answer without examining the meaning of the question and making some necessary distinctions." Such prudence in dealing with vague concepts of the meaning of human history, with the numerous alleged 'laws' and explanations of the growth of human society, was very much in the character of the late Morris Cohen's writing. Lucid, careful in distinguishing, ready to postpone acceptance of a solution of a problem if it had no more to commend itself than that it solved part of the problem, these were the intellectual merits manifested in all his writing; and they are manifested in these posthumously published Carus Lectures.

Morris Cohen was not totally unimpressed by the claims of some of these systems of historical prediction or explanation. "Various theodicies, systems of evolution, and physical, political, economic, or other interpretations of history have all tried to make the endlessly complicated web of history conform to a pattern based on some happy guess." Morris Cohen did not deny importance to happy guesses; what he did deny was that a guess was more than a guess or that any of these systems answered all the questions which an intelligent observer of human society is forced to put to himself. Biological and physical conditions are of great importance, but they cannot explain all that puzzles us in the growth of human society. Religious beliefs, economic organisation, even that much despised category 'great men', all play their part. But they do not play the whole part. Few writers were less affected by mere fashion, or by the prestige or the lack of it attaching to any particular doctrine.

Morris Cohen was not easily impressed, and among the great names that in this connexion fail to impress him greatly, or at all, are Hume, Bacon, Marx, Freud, Karl Pearson, Croce. Nor are doctrines more reverently handled. Crude forms of determinism which, if examined, turn out not to be deterministic; what passes for the history of science (a theme he returns to again and again); simple-minded views of progress; all are examined and their weaknesses made plain. But his disregard for fashion works the other way, too, in the defence of the social contract theory, in the almost lyrical praise of the scientific pioneers of the University of Padua, in the affirmation of ethical claims with which the lectures end. No reader of these lectures will end them without having been forced to think a little more clearly on the question of historical causation, on the necessary conditions of certain types of intellectual progress, on social institutions like the city.

It is human to note that Morris Cohen did no always observe his own rigorous canons of historica proof. It is difficult to see how (on his principles) we can even guess that "there is probably less happiness in Europe to-day than in the eighteenth century, or even in the nineteenth". Nor is the statement that "Germans have changed their character in historic times, e.g. since Kant" invulnerable to the kind of criticism Cohen directed against rash generalizations based on the selection of arbitrary examples and too confident use of correlations. The population of Prussia, when it was still almost entirely agricultural cannot have been as dense as is stated on p. 183. It would (if these figures are right) have been as densely populated as modern Belgium or modern Saxony. If square miles are replaced by square leagues, it is intelligible. Then, Chamisso and La Motte Fouqué do not make the point against naïve race doctrines of nationality nearly as well as do other Germans of French origin, Savigny, von Verdy du Vernois, von Arnaud de la Perière, or Du Bois Reymond. It is the printers, presumably, who mis-spell Schrödinger and Lecky. Morris Cohen gave no comfort to the enthusiasts who thought and think that the growth of human society can be studied in the manner, and with the presumption of results, that we are accustomed to in the physical sciences. But he was convinced that it could be studied with profit, to the enlargement of our social imagination, to the understanding of our problems and to the reinforcement of our belief that there is ethical progress and that its chief enemy is not brute force but "negligence in the pursuit of the right".

D. W. Brogan

PRACTICAL AND DESCRIPTIVE ASTRONOMY

Practical Astronomy

By Prof. Jason John Nassau. (McGraw-Hill Astronomical Series.) Second edition. Pp. xii+311. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 30*s*.

New Handbook of the Heavens

By Hubert J. Bernhard, Dorothy A. Bennett and Hugh S. Rice. (Whittlesey House Publication.) Revised edition. Pp. xi+360. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 18*s*.

Astronomy

By William T. Skilling and Robert S. Richardson. Revised edition. Pp. xi+692. (New York: Henry Holt and Co.; London: Chapman and Hall, Ltd., 1948.) 28*s*. net.

Worlds Without End

By Sir H. Spencer Jones. Revised edition. Pp. xv+262+32 plates. (London: English Universities Press, Ltd., 1948.) 10*s*. 6*d*. net.

PROF. J. J. NASSAU'S book is intended for students in civil engineering who have had no other course in astronomy, and for other students who wish to do some observational work to supplement the theoretical side of their study. This second edition incorporates revisions and additions, which have resulted in a fifty per cent increase as compared with the first, published in 1931. Part 1 deals with fundamental principles and ordinary determinations of time, latitude and longitude, as well as with the instruments used for these purposes. Part 2 presents all the advanced material necessary for field-work in geodetic astronomy, and includes a description of the modern astrolabe and its use in determining the geographical position of the observer. The book is adequately illustrated and is a most useful handbook that should satisfy all the needs of those for whom it is intended. The fact that it is designed for use with the "American Ephemeris" need not deter readers in other countries, as the tables required are similar to those published in other national ephemerides. Moreover, the ones needed for working out the examples given in the book are reprinted at the end of the volume.

The three remaining books are popular descriptive expositions of general astronomy. The first, "New Handbook of the Heavens", is apparently intended for the layman with no previous knowledge of the subject. The style of writing varies from one part of the book to another, the result presumably of multiple authorship. Certain of the chapters could be read with pleasure and profit by any keen amateur astronomer; but the treatment of others is so elementary and the terminology so over-simplified as to provoke the suspicion that use has been made of material originally intended for purposes of nursery instruction. Any reader who can stand up to this will find the book interesting enough, especially as, in addition to giving a simple general survey of the universe, it justifies its title by the inclusion of maps of the stars, lists of objects worthy of observation and hints on the use of a small telescope. A list of future eclipses and a short glossary of technical terms are useful features. Here and there are some misleading statements, as, for example, where the reader is told that a 9 to 12-in. telescope with a power between 400 and 500 is needed to reveal the disk of Uranus, and that Pluto is a difficult object in a 15-in. refractor. But these are small blemishes in a book that is likely to prove attractive and useful to the beginner in observational astronomy, and in any case it cannot do less than whet his appetite for something more advanced.

In Messrs. Skilling and Richardson's "Astronomy" we have something much more in the nature of a general text-book, albeit of an elementary and non-mathematical kind. It is, in fact, one of the best of its type and deserves the success which it has enjoyed since the first edition was published in 1939. As often happens in such books, the treatment of the various subjects is rather uneven; but probably there has never yet been produced a general astronomy on which a specialist will not have some criticism to make of the presentation of his own particular branch of the science. In this book, for example, the chapters on the sun and on solar and stellar spectroscopy seem to be particularly good, whereas other parts of the subject are less satisfactorily treated. Among minor errors is the incorrect statement of the modern meteoric theory of the formation of the lunar craters; and, in spite of several good and authoritative accounts of Herschel's life that have been published, the reader is given to understand that the astronomer was knighted by George III on the occasion of the discovery of Uranus, whereas, in fact, the honour was conferred on him by the Prince Regent some thirty-five years later, when he was quite an old man. A drawing and some photographs of Mars, made presumably from lantern slides, have been reversed east–west and are thus scarcely recognizable. But in spite of all defects the book remains an excellent general astronomy. Some of the illustrations are particularly good.

Of the Astronomer Royal's book, "Worlds Without End", which, like the three already mentioned, is a revised edition, it will be sufficient to say that it is the ideal popular sketch to put into the hands of any person, young or old, who is in need of a simple introduction to a profound subject. Though it is free from mathematics, it is packed with interesting facts, and the information contained in it has been brought right up to date. The treatment of the subject is remarkably lucid; and the illustrations are adequate, though one or two of them have not been very well reproduced.

W. H. Steavenson

SPIRITUAL HEALING

George Fox's "Book of Miracles"

Edited with an Introduction and Notes by Henry J. Cadbury. Pp. xvi + 162 + 8 plates. (Cambridge: At the University Press, 1948.) 21*s.* net.

It was over a quarter of a century ago that *Nature*, in discussing the report of the committee on spiritual healing set up in accordance with Resolution 63 of the 1920 Lambeth Conference, said that the committee had set aside or failed to solve "problems of the greatest magnitude and importance from the scientific point of view". Ten years previously, another clerical and medical committee had issued a report on which precisely the same judgment could legitimately have been pronounced, while to-day we are still in the same state of ignorance in spite of the activity among us of at least two 'spiritual healers' claiming remarkable powers.

In view of these facts it is interesting to cast the mind back to the work of the Quaker leader, George Fox (1624–91), whose manuscript "Book of Miracles", now lost, has been partially reconstructed through the labour of Dr. George Cadbury, who, in the present volume, has given us the result of his work. In "The Annual Catalogue of George Fox's Papers", which was made in 1694–98, an index was appended, and in this are included notes of the entries incorporated in the "Book of Miracles" which provide clues to the nature of the fuller accounts in the lost manuscript. By collecting these entries and supplementing the meagre information they supply from other sources, Dr. Cadbury has succeeded in presenting a tolerably clear account of the book and the nature of the miracles with which it dealt. In addition, he has printed an admirable summary of the situation as regards Quaker miracles, especially those relating to healing and kindred remedial measures.

Perhaps one of the most striking features of Fox's account is the absence of any flamboyant or spectacular claims to cure clearly organic diseases. Just as was the case with the committee of 1924, so here we are led to the provisional conclusion that little evidence is to be found that the alleged miracles cannot be paralleled in ordinary modern psychotherapeutics or in cases of spontaneous healing recognized by medical science. The kernel of the controversy is easy to discern. In the report of the committee of 1924 the theological section was naturally inclined to the view that the source of the healing power was *external* to the patient, while the medical and scientific members looked rather to an activity *within* the patient although manifestly put into motion through external stimuli. In the case of George Fox and the Quaker healers, this belief in Divine intervention was clearly implied in the "Book of Miracles", and the same may be said of many modern healers who believe their success is due to the operation of 'spirit doctors', with whom they are in some mysterious manner connected but whose powers they in no wise control.

For those who want a clear summary of the state of spiritual healing in George Fox's day, Dr. Cadbury's volume is essential, and he is to be congratulated on the care with which he has prepared his scattered material and the fascinating manner in which he has presented it.

E. J. DINGWALL

STUDY OF MOLECULAR STRUCTURE

Contribution à l'étude de la structure moléculaire

Dédiée à la mémoire de Victor Henri par R. Audubert, R. F. Barrow, A. Burawoy, C. A. Coulson, L. Couture, M. de Hemptinne, M. L. Delwaulle, J. Duchesne, J. Franck, F. François, P. Goldfinger, H. v. Halban, M. B. Hall, A. Kastler, V. Lasareff, J. Lecomte, M. Letort, M. Magat, C. Manneback, J. P. Mathieu, A. Mertens, H. Moureu, M. Niclause, L. Pauling, M. H. Pirenne, I. Prigogine, B. Rosen, H. Sponer, M. J. Stallcup, P. Sue, H. W. Thompson, E. E. Vago, A. D. Walsh, E. Warhurst, K. Wieland, R. Wurmser. Préfacé par L. Brillouin et par J. Duchesne. Pp. xiii+314. (Liège: Maison Desoer, 1948.) N.p.

THIS volume has been prepared in commemoration of Victor Henri, who died in 1940. V. Henri occupied the chair of physical chemistry at the University of Liège for almost ten years, and he developed there a remarkable school of molecular spectroscopy, kinetic chemistry and photochemistry. The twenty-seven papers in this book elaborate topics in which he was interested. The concept of predissociation was introduced by V. Henri following his discovery of a diffuse appearance in the discontinuous structure of certain spectra, and so it is particularly pleasing to record that two of the papers in this collection are devoted to this subject.

No attempt will be made here to discuss the papers in detail, but some trends may be noted. A large proportion of the papers are concerned with spectroscopy, and the majority of these discuss work on the infra-red and Raman spectra, while a few are devoted to the ultra-violet and visible régions. There are two papers on reaction kinetics. The equilibrium postulate which occurs in the theory of absolute reaction-rates is examined in one paper, while the other is concerned with the possibility of systematizing the treatment of certain chain reactions. The editorial committee has not attempted to present a balanced review of molecular structure, and, as a result, an examination of subjects such as X-ray diffraction, electron diffraction and dipole moments is not made in this volume. Theoretical papers on the atomic radius of carbon, cross-terms in the potential functions of polyatomic molecules and the calculation of bond-lengths are included. These contributions illustrate recent advances which have resulted from the extension of the work of Mulliken, Pauling and others. The paper presented by Burawoy, entitled "The Supposed Existence of Non-localised Electrons, Resonance and Stereomerism", is in sharp contrast with this series. Burawoy argues that the theory of resonance is in disagreement with numerous facts, and he supports the view that all constitutive changes are accounted for by inductive electronic displacements.

Inspection of the list of names of contributors should be sufficient to recommend this work, but it must be admitted that much of the substance of some of these papers has appeared elsewhere.

E. F. G. HERINGTON

THE BRITISH PHARMACOPŒIA

The British Pharmacopœia 1948

Published under the direction of the General Council of Medical Education and Registration of the United Kingdom. (Published for the General Medical Council.) Pp. xl+914. (London: Constable and Co., Ltd., 1948.) 45s. net.

"THE British Pharmacopœia" was first published in 1864, and revisions appeared in 1874, 1885 1898, 1914 and 1932. The seventh edition, which was issued in 1948, is a great advance on its predecessors. The world is much indebted to the Pharmacopœia Commission and particularly to its chairman, Prof. J. A. Gunn, and to its secretary Dr. C. H. Hampshire, both of whom have served the Commission for many years. They helped to produce the edition of 1932 and have been primarily responsible for the issue of six addenda during the difficult days of the War and for the fine book now before us. A large number of other people have made lesser contributions, and more than fifty papers have been published in scientific journals to record the results of investigations undertaken at the request of the Commission.

This Pharmacopœia represents more work than any of its predecessors; it is good to know that most of this work was undertaken from a sense of public duty without hope of personal gain. The book has grown from 713 to 914 pages. One innovation is the admission of a number of substances still protected by patent rights; another is the inclusion of the structural formulæ of many organic substances The list of tablets was greatly extended in the addenda and has now been still further increased, so that there are about fifty different preparations of this sensible type. The 1932 edition contained only six 'injections', and the number has now grown to seventy-five. This reflects a change in therapeutics; but the increase is not as large as appears at first sight, since some preparations (such as pituitary extract) have joined this group by changing their names, and others (such as neoarsphenamine) have for long been given by injection without the dignity of a separate monograph.

Doses are still given both in the metric and Imperial systems. It is to be hoped that the Commission will soon decide that the time has at last come to drop the older system altogether, as other pharmacopœias have done; the present state of affairs is confusing and absurd. New drugs are generally described in grams or mgm., older drugs in drachms or grains. The older physicians have always been reluctant to learn metric doses and have taught the older system to their juniors. If the Commission took a strong line, there would no doubt be a bitter outcry at first; but the final result would be good.

J. H. GADDUM

James Clerk Maxwell, F.R.S., 1831–1879

By Dr. R. L. Smith-Rose. (Science in Britain Series: Published for the British Council.) Pp. vi+34+7 plates.

Lord Kelvin

By A. P. Young. (Science in Britain Series: Published for the British Council.) Pp. vi+42+7 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 1*s.* 6*d.* net each.

THESE are two welcome additions to the "Science in Britain" series, published by the British Council; for no survey of British science would be complete without some account of James Clerk Maxwell and Lord Kelvin, two of the great figures of the nineteenth century, and of the work which is associated with their names.

Maxwell's name is inseparably connected with his great achievement, the electro-magnetic theory of light, and many are familiar with the story of how, starting from the earlier, non-mathematical speculations of Faraday on the mechanism of propagation of magnetic disturbances, he reached the conclusion that the velocity of the impulses is the same as that of light. The prediction was afterwards verified experimentally by Hertz; and the practical consequences which have flowed from the application of Maxwell's theory of wave propagation are now widely appreciated. Dr. R. L. Smith-Rose has written an excellent short survey of the life and work of this great theoretical physicist, including also some account of his contributions to molecular physics and the kinetic theory of gases.

Kelvin was a man of a different stamp. Although he made theoretical advances in the field of thermodynamics, the importance of his work lay rather in the application of his wide knowledge of physical principles to invention. Besides his work on the fundamental electrical units and on the construction of precise electrical measuring instruments, which has proved to be of outstanding importance, he made valuable contributions in the field of instrument design to the art of navigation, among them the improvement of the mariner's compass; and he was one of the pioneers in the laying of the Atlantic cable. In his later years Kelvin as a physicist found difficulty in accepting the modern developments in physical theory; and Mr. A. P. Young's essay shows how his prejudices and limitations in this respect contrast with his outstanding achievements in the field of engineering in which he was supreme.

T. M.

Whitehead's Philosophy of Time

By William W. Hammerschmidt. Pp. ix+108. (New York: King's Crown Press; London: Oxford University Press, 1947.) 11*s.* 6*d.* net.

ONCE again, the King's Crown Press has done good service to scholarship in producing this monograph. Of all the great thinkers, Whitehead is one of the most difficult to read: this is not wholly because his thought is so profound, but partly it is on account of his use of a very special vocabulary. In addition, his views on Nature were undergoing continuous transformation, which resulted in some of his terms connoting different things at different periods of his life. Nowhere is this tendency more marked than in his philosophy of time, and for that reason alone Dr. W. W. Hammerschmidt's monograph would be welcome. As it is, on many other scores it should prove its worth, not least because we have here an attempt to bring some logical order into Whitehead's prodigious output. One would not desire, or indeed expect, regimentation to be characteristic of so sublime a creative artist; but his commentator has done well to stop short of organising the master's work more thoroughly than he seemed to intend.

So far as time is concerned, Whitehead throughout maintains something of an empirical basis, or, at least, he does for the fundamental properties of space-time. What undergoes progressive change is the place accorded to the nature of immediate experience. The present author keeps this dynamic aspect in true perspective as he unfolds the scene leading up to and through the Theory of Process.

Books *about* great men and their lives are apt to be disappointing; this one avoids that sensation, largely because it is impersonal and self-forgetful. It will help those who wish to study "experience dominated by emotion and experience under self-restraint" as time rolls onwards.

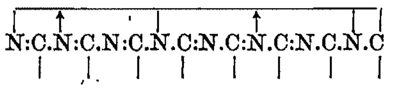
F. I. G. RAWLINS

The Chemistry of Organic Cyanogen Compounds

By Vartkes Migrdichian. (American Chemical Society, Monograph Series, No. 105.) Pp. ix+460. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 72*s.* net.

THE American Chemical Society was wise in devoting No. 105 in its monograph series to organic cyanogen compounds, for they find ever-increasing application, both in research and in technology. Indeed, the review may even be overdue, for Dr. V. Migrdichian has found it necessary to restrict himself rigidly to the *reactions* of organic cyanides. Thus, the physico-chemical attributes of the group find no mention, and preparative methods for even the most important nitriles are summarily dismissed, sometimes, unfortunately, with obsolete methods.

Within these limits the book is well conceived. Each typical reaction of the cyanogen group is selected and surveyed in turn to produce a condensed and comprehensive whole. Indeed, the amount of work reported is quite astonishing, and to some extent the review is correspondingly valuable. While the scope is satisfactory, the review, however, lacks an adequate critical approach to its material. This has resulted in errors, a certain irrationality within the chapters and at least one complete contradiction within the space of a few lines. The adoption, in part, of the *Chemical Abstracts* system of reproducing graphic formulæ has produced some surprising results without saving much space. Will many readers recognize the beautiful symmetry of the phthalocyanine molecule in the following guise:



$$\mathrm{N{:}C.N{:}C.N{:}C.N.C{:}N.C{:}N.C{:}N.C.N.C}$$

Indexing is extensive and complete, but the irrationalities of the book are reflected and form a trap for the unwary. For example, there are a number of references to acrylonitrile and others quite separate and unco-ordinated to vinyl cyanide. The numerous errors of reproduction are more appropriate to a galley proof than to an expensive work of this nature.

STANLEY L. THOMAS

A Scheme of Qualitative Organic Analysis

By Dr. Frederick J. Smith and Emlyn Jones. Pp. vii+320. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1948.) 17*s.* 6*d.* net.

THE student of organic chemistry will find in this book an excellent presentation of qualitative organic analysis along familiar lines. After application of the tests for elements and the usual preliminary examination, classification tests enable the experimenter to assign the substance under investigation to its class. Confirmatory tests are then made, and crystalline derivatives prepared by means of which the substance is finally identified. Many valuable tables are provided listing individual members of the various classes, with their physical constants, and suitable derivatives for their identification. The range of these tables is more comprehensive than is usual in a book of this standard. Numerous up-to-date tests have been included, and the reviewer has noticed very few errors apart from a confusion between m.p. and b.p. in the headings of several tables.

It is not to be expected that full details of microtechnique should be given, yet it would have been worth while to include a description of a micro-filter, which is so easy and cheap to assemble and so useful in dealing with the small amounts of material often isolated in preparing derivatives. The book is admirably produced and well indexed, and it will be found useful in many laboratories. G. M. B.

Fatty Acids and their Derivatives

By A. W. Ralston. Pp. ix + 986. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 60*s.* net.

DR. A. W. RALSTON must be congratulated on the production of this excellent volume, for there are few features in the long and tangled history of the fatty acids which have escaped his notice or defied his logic.

In his first five chapters he has regimented the one-time ruck of fatty acids to orderly array and paraded them for our benefit. Group by group those acids containing more than six carbon atoms are described—saturated, ethylenic, acetylenic, hydroxylic, ketonic, cyclic and dicarboxylic, all are there, with occurrence, isolation, synthesis and physical properties carefully portrayed. The naturally occurring fats, oils and waxes are considered only incidentally as sources of the acids. In the second section of his book Dr. Ralston describes the preparation, physical and chemical properties, and certain uses of the fatty-acid derivatives. Successive chapters describe, first, those derivatives not involving modification of the carboxyl group, then the esters, the nitrogen-containing derivatives, the alcohols, ethers, mercaptans, sulphides and sulphonates, the anhydrides, acid chlorides, aldehydes and ketones, the hydrocarbons and the metallic soaps. Then, since the ordering of so much material cannot be instantaneous, Dr. Ralston has provided an appendix to bring his survey up to date.

In the face of so much excellent material it is ungracious to criticize, and if, occasionally, Dr. Ralston may be thought to over-simplify a little, he has provided a more than adequate bibliography through which one may pursue any chosen line. This carefully written and well-indexed volume will come to be a trusted friend to all workers in the field.

How Greek Science Passed to the Arabs

By the Rev. De Lacy O'Leary. Pp. vi+196. (London Routledge and Kegan Paul, Ltd., 1948.) 15*s.* net.

THE title of this book is perhaps somewhat mi leading, for much the greater part of it occupied by a clear and scholarly account of th general history of the Near East during the perio between the conquests of Alexander and the tent century A.D. The book thus presents valuab material for the student of the science of this period but the emphasis is on the background rather tha on the science. A work intended for the gener reader should give some account of the nature an extent of the scientific knowledge that passed fro the Hellenistic world to Islam; but, in fact, he do not find much beyond the names of works, with man of which he may be unfamiliar. The reviewer note with some astonishment that the author does not much as mention alchemy or chemistry, the transf of which presents interesting and important problem on which a good deal of work has been done. Th proof-correction of the book is much at fault; suc errors as Antonius for Antoninus, Ultianus f Ulpianus, may mislead the reader and must sha his confidence in the correctness of the many nam he will meet for the first time in these pages. Th author cites a few formulæ in illustration of India and Arab mathematics; these appear in forms erroneous as to be scarcely recognizable. In spite these defects, which might easily be removed in second edition, the book satisfies a real need giving a compact account of a period which, while is little studied except by specialists, is of the fir importance to the historian of science.

F. SHERWOOD TAYLOR

Look and Learn

The New Pictorial Encyclopædia. (*Daily Ma* School-Aid Publication.) Pp. 112. (London Associated Newspapers, Ltd., n.d.) 7*s.* 6*d.* net.

Look and Learn

The New Pictorial Encyclopædia. Series 2. (*Dai Mail* School-Aid Publication.) Pp. 112. (London Associated Newspapers, Ltd., 1948.) 7*s.* 6*d.*

INCREASING emphasis on visual methods learning have prompted the School-Aid Pu lications Department of the *Daily Mail* to issue series of books in which the role of the text an illustrations in the usual text-book are reverse Here the 'story' is told by means of photographs an diagrams, the text being introduced incidentally supplement the interest built up by the illustration This novel approach is undoubtedly one which h much to commend it and one which will be pa ticularly well received by teachers of more backwa pupils in primary, secondary modern and day co tinuation schools. But the publishers should bewa lest the interest they create through their pictur leads quickly to a state of mental confusion in t readers. In one book alone they include thirty-o topics, each of which is packed with informati which needs time to consider. The impression gain is that topic succeeds topic without any clear d marcation, so that some not-so-bright student mig easily include the Tower of London as a bra instrument of the orchestra. The books would ha greater effect if fewer topics were included and dea with at greater length. The pattern for these mig be based on the stories of America and Austral which are included in these books and which ha been excellently devised and elaborated. T. H. H.

SOLAR FLARES AND THEIR TERRESTRIAL EFFECTS[*]

By Dr. M. A. ELLISON
Royal Observatory, Edinburgh

THERE is no more fascinating problem in astrophysics at the present time than that of the rigin of solar flares and of the remarkable train of vents to which they give rise.

It is less than twenty years since Hale (1931)[1] lirected attention to chromospheric eruptions as a haracteristic type of solar activity. In recognizing heir influence upon terrestrial magnetism he called or priority to be given to their study in the co-perative programme of spectrohelioscope observaions of the sun's disk in hydrogen light then being rganised under the auspices of the International stronomical Union. The term 'flare', later proposed y Richardson, has gained general acceptance, though éruption chromosphérique' is still employed on the ontinent to denote the same phenomenon.

A 'flare' may be described as a sudden, short-lived ncrease in monochromatic radiation occurring in a imited region of the chromosphere and in the vicinity f an active sunspot group. Flares are classified on a isual scale of importance, 1 (smallest) to 3 (largest), higher 3+ category being reserved for those of reatest area and intensity and which are accomanied by marked geophysical disturbances. They ccur within a radius of 100,000 km. of a visible unspot and most frequently between the leading and ollowing components of a bi-polar group. The atches of bright emission have a life-time varying rom five minutes to one hour or more; in appearance hey range from the smallest points of light visible n the spectrohelioscope, covering only a few nillionths of the sun's visible hemisphere, to great white-hot' ropes and filaments (Fig. 1) which may tretch right across and obscure the largest of sunpots (area $\sim$ 5,000 millionths, or 5,860 million quare miles). The rise to peak intensity for a flare nay be extremely rapid, sometimes occurring as a lash' of radiation followed by a slow decay. Photonetric measures of the intensity in $H\alpha$ light, or neasures of the effective width of the $H\alpha$ emission ne, provide suitable means of following quantiatively the characteristic sequence of light variation. evelopment curves, such as that shown in Fig. 2 ower), reveal the very brief duration of the flash hase which occurs in the early stages of an intense are; the existence of this had previously not been etected by visual observations alone. These curves lso form a valuable standard of comparison when e seek to correlate flares with their ionospheric and eomagnetic effects. Moreover, any working hypohesis of flare generation should have, as one of its rimary aims, to account for this peculiar type of ght-curve.

Flare Spectra

The rarity of intense flares, their sudden and nexpected onset and their short duration all conpire to defeat the most patient spectroscopist. The w records which have been secured[2-5] indicate that ares of comparable $H\alpha$ intensity produce similar, hough by no means identical, spectra. The chief atures in the visible region are the bright reversals in the Balmer absorption lines of hydrogen, in neutral helium and in the lines of ionized calcium, iron, silicon and a few other metallic atoms. The hydrogen emission lines are often of great width, like that photographed at Sherborne (Fig. 3*a*) near the time of peak intensity of the 3+ flare on July 25, 1946. In contrast to this, however, the reversals of the *H* and *K* lines of ionized calcium and of the other metallic lines are much narrower. This circumstance points to the Stark effect[6] rather than the Zeeman effect as a possible cause of the wide wings seen in the hydrogen lines during the 'flash' phase. If this proves to be the correct explanation, we may infer that there exists for a short time in the flare region a high concentration of electrons, such as might accompany a large-scale discharge or 'lightning flash', taking place in the complex electric and magnetic fields known to exist in the vicinity of a sunspot.

Towards shorter wave-lengths, less than 3000 A., the solar spectrum is completely blotted out by the ozone and other absorptions occurring in the lower layers of our atmosphere. We have, therefore, as yet no means of recording directly the spectral characteristics of flares in the ultra-violet region. The recent extension of the Fraunhofer spectrum down to 2100 A., by means of spectrographs borne aloft in *V2* rockets[7], though a remarkable technical achievement, is of little value to the flare spectroscopist. His heavy apparatus would need to be raised at least 200 km. above the earth's surface and to be held in accurate alignment on a small and uncertain point of the sun's disk until the moment of opportunity arrived. However, the lines of hydrogen and helium in the visible region, coupled with the ionospheric effects of flares, enable us to infer the presence in emission of the Lyman series of hydrogen ($L\alpha$ 1215 A., $L\beta$ 1026 A., etc.) and of the

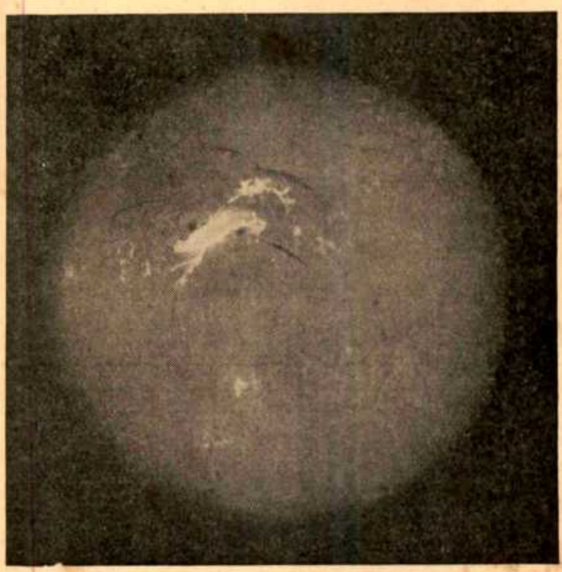


Fig. 1. Great solar flare, July 25, 1946 (Meudon)

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[*] Substance of a lecture delivered to the Radio Section, Cavendish aboratory, Cambridge, on October 26, 1948.

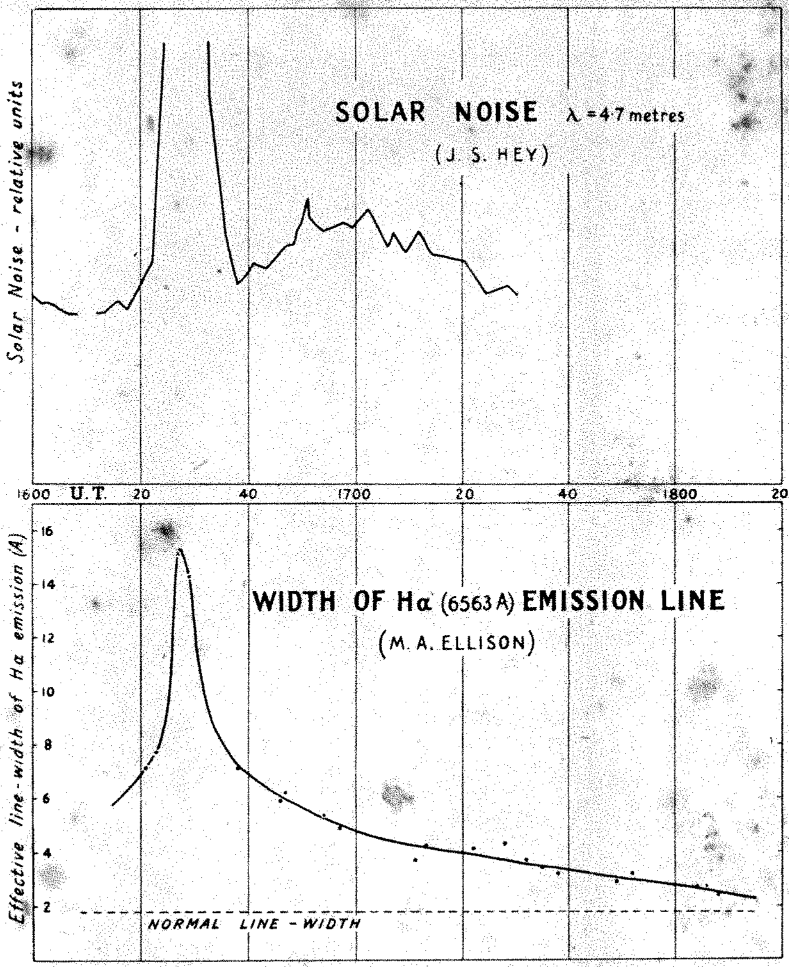

Fig. 2

resonance line of neutral helium at 584 A., though it is still a moot point to what extent these radiations may suffer re-absorption in the chromosphere before emergence. Certainly in the visible range the $H\alpha$ emission line at times shows strong chromospheric absorption superimposed upon the line centre; but it is significant that in this case the wings of the line, which are thought to be broadened by the Stark effect, emerge undiminished in brightness. The degree of this central absorption seems to be indicative of the very variable height at which flares may occur within the solar atmosphere[5].

In addition to monochromatic emissions in discrete wave-lengths, enhancements of the continuous spectrum of flares are to be expected in the ultra-violet. Such a brightening of the continuum in the region of 1000 A. would possibly have its greatest effect in the oxygen ionization of the terrestrial E-layer. A similar brightening of the continuous spectrum has been photographed in the visible region during an intense flare[4], and on other occasions flares have also been rendered visible for a short time in integrated (white) light by this cause.

The absence of Doppler shifts in the spectral lines is an indication that flares are nearly stationary in height, nor have any large horizontal motions been observed relative to other chromospheric features. In this respect they stand in striking contrast to the sunspot prominences (seen as small dark filaments on the disk) the velocities of which are frequently greater than 10 km./sec.

In the radio spectrum, intens emissions in association with flare have been reported by Hey, Parsons and Phillips[8] and by othe workers. These radio bursts, a they have been called, are superimposed upon the more continuous 'radio noise' emissio which is characteristic of th presence on the sun's disk o specially active sunspots exceeding in area about 1,000 millionth of the visible hemisphere: th bursts exceed the level of the continuous emission by a factor o 10–100 times. Both the continuous emission from the spot and the bursts associated wit flares can be detected over band of wave-lengths from 1 t 20 metres, with a maximum intensity usually in the region o 5 metres. It is not clear a present whether this limited rang and 5-metre peak are both determined by the varying transparency of the ionosphere t different wave-lengths, or to wha extent they represent a rea change in spectral intensity wit wave-length. Hey[8] has show that on occasions the nois burst at 4·1 metres wave-lengt lags several minutes behin the observed peak of the H emission.

Ultra-violet Effects

The geophysical effects of flare are derived from two different causes: (A) the wav radiations (mainly ultra-violet) which we have bee discussing, and (B) certain corpuscular emissions to b referred to later. The former give rise to the *simul* *aneous* effects, the latter to *delayed* effects after a interval depending upon the travel-time from sun t earth of the particles concerned. Let us conside first the ultra-violet effects.

(i) *Geomagnetic 'Crochets'*. These characterist perturbations of the magnetic needles have bee known to be associated with specific solar outburs since the classic observation of Carrington an Hodgson of an intense solar flare in white light o September 1, 1859. This was accompanied by synchronous disturbance of the Greenwich magnet traces, having a duration of about one hour and range of +16′ in declination and −110 γ in horizont force. In a recent summary of the Greenwich record Newton[9] has assembled an impressive amount evidence for the synchronous occurrence of 'crochet and intense (3 or 3+) flares. While the 'crochet are confined to the daylight hemisphere of the eart their occurrence is further restricted, for reasons n yet clearly understood, to regions within about 7 of the sub-polar point. The comparisons made wit visual observations show that the 'crochet' distur ance follows very closely in amplitude and duratio the course of the flare development as recorded i $H\alpha$ light. The mechanism of 'crochet' formation

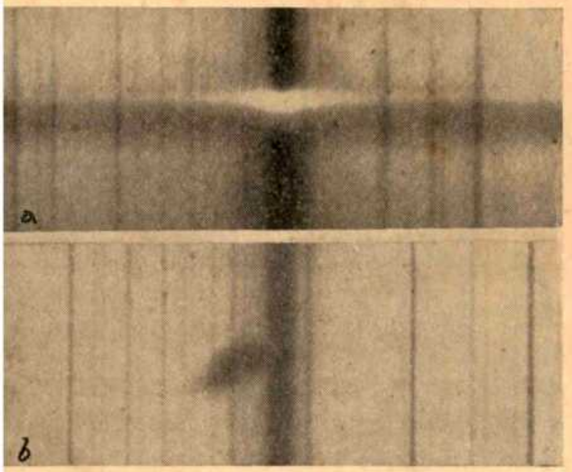

Fig. 3 (*a*). Flare emission line (*Hα*), July 25, 1946 (Sherborne); (*b*) Doppler displacement (140 km./sec.) of surge ejected by a flare (Edinburgh)

not known with certainty; the most favoured hypothesis is that which assumes the sudden movement of a conductor in the earth's magnetic field, such as, for example, the convective motion by heating of an existing or newly formed ionized layer n the ionosphere. In other words, according to McNish[10], the crochet phenomenon is to be regarded as a sudden intensification of the normal diurnal variation of the magnetic elements.

(ii) *Short-wave Radio Fade-out.* Next, in order of discovery, is the so-called Dellinger[11] effect (1935). Suddenly, within the space of a minute or so, short-wave (10–50 metres) channels of communication suffer a partial or complete interruption, at least if any part of them happens to lie in the sunlit hemisphere of the earth, from which we deduce that the cause is a wave- and not a particle-effect. The fade-out is found to be synchronous with the flare and comparable in duration with its visibility in $H\alpha$ light. The immediate cause of the fade-out is the formation of a newly ionized non-reflecting layer at a height of 70–90 km., the cause of which is usually ascribed to he resonance line of hydrogen, Lyman α. This emission line (1215·7 A.) in a flare must have an intensity and a line-width far exceeding those we have recorded in the visible spectrum for $H\alpha$. This in itself would not give rise to atmospheric ionization; but it so happens, as was first noted by Chapman and Price[12], that the resonance line of atomic oxygen has a wave-length of 1217·6 A. The wide wings of $L\alpha$ will certainly overlap this oxygen line for the greater part of the life-time of a flare. Terrestrial oxygen atoms will thus be excited, and if left to hemselves will immediately return to the ground-tate. In the denser atmospheric layers at 70–90 km., however, collisions with other particles will be sufficiently frequent and will supply sufficient energy o bring about ionization of the excited oxygen atoms before they have time to re-radiate.

(iii) *The Long-wave Phase Anomaly.* A new and very sensitive means of measuring the changes in D-layer ionization has recently been perfected by Bracewell and Straker[13], of the Cavendish Laboratory, Cambridge. In these investigations the transmitter *GBR* at Rugby, emitting waves of frequency 16,000 cycles per second (about 19-km. wave-length), is usually employed. Two waves from Rugby are eceived at Cambridge, the ground wave and the sky wave by reflexion from the ionosphere. There is a phase difference between the waves arriving by the two different routes, the value of which shows a characteristic diurnal variation depending upon the changes in effective height of the reflecting layer between day and night. When a solar flare occurs a sudden change of phase is recorded, representing a fall in the effective height of the reflecting layer. An intense flare, for example, may cause a phase change as great as 500°, corresponding to a lowering of the reflecting ceiling by 15 km. The sudden onset is followed by a slower recovery to normal. In Fig. 4 is shown a detailed comparison between such a phase anomaly and an $H\alpha$ line-width curve for a flare (June 7, 1948) measured with the spectrohelioscope at Edinburgh.

Flares of the lowest intensity (1) on the visual scale are found to produce measurable anomalies, and solar physicists welcome this development as a more powerful and reliable means of recording flares during prolonged periods of cloudy weather when spectrohelioscope observations are impossible. In clear weather, also, it may be employed as a warning device to enable workers to train their spectrographs on active solar regions and so to pick up flares which would otherwise pass unobserved. Moreover, it seems very probable that a detailed study of the shapes of the anomalies, by comparison with the line-width observations of $H\alpha$ emission, will decide whether or not it is the $L\alpha$ radiation from hydrogen atoms which is the active agent in disturbing the ionosphere at such times.

Particle Effects

(i) *Geomagnetic Storms.* Maunder (1904) was the first to demonstrate that great magnetic storms (range in $D \geqslant 1°$, H or $V \geqslant 300\,\gamma$) on the earth coincided approximately in time with the passage of large sunspots across the sun's central meridian. More precisely, he found that the storm began, on the average, about 26 hours after the central meridian passage of the sunspot, corresponding to a position of the spot in long. 14° W. The converse of this was not true, that the central meridian passage of every large spot was followed a day later by a magnetic storm. The connexion with sunspot regions was thus established; but the cause of the connexion as well as its delayed action remained obscure. Lindemann (1919) suggested that the agency responsible for the storms consisted of clouds of ionized gas ejected by radiation pressure from the sun. Later, Chapman and Ferraro[14] showed how such storms could be produced and even their detailed characteristics

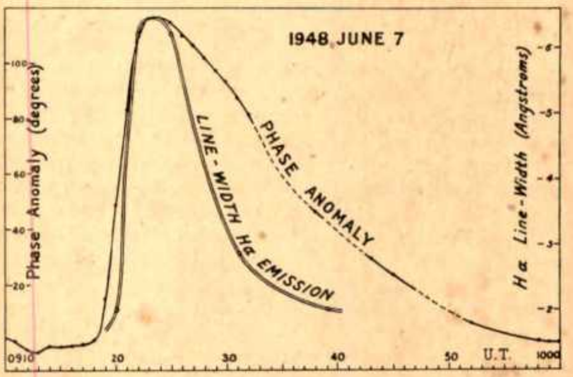

Fig. 4

explained on their theory of neutral ionized streams of corpuscles emitted from limited regions of the solar surface. What were the source points of these corpuscular streams? Were they continuous or intermittent? And why did some large sunspots appear to generate them, others not?

In 1944, Newton[15] completed his comprehensive analysis of the data of association between intense flares and great magnetic storms occurring about one day later. This paper produced an almost overwhelming case in favour of a direct causal connexion between the two phenomena. The time interval (storm begins *minus* flare first observed) given by the data was 25·7 ± 1·5 h.; but the largest of five great storms gave 20·3 ± 0·9 h., and this difference of particle travel-time was considered to be a real effect in view of the probable errors. An examination of the angular distances from the centre of the sun's disk of the flares preceding great storms led to the conclusion that the storm-generating agency failed to reach the earth if the flare was located farther than about 40° from the central meridian.

These facts are consistent with the formation at the time and place of the flare of a single, short-lived blast of corpuscles confined within a cone-shaped beam the vertical angle of which is about 90°. If the earth at the time is suitably placed in its orbit, it will make a 'head-on' collision with the base of this cone as it expands outwards at a speed of about 1,600 km./sec. The Chapman and Ferraro mechanism then comes into play, and the characteristic 'sudden commencement' of the storm traces represents the arrival of the first particles in the polar ionosphere. The aurora borealis and australis are the well-known visible accompaniments of these particle streams. Indeed, the aurora is Nature's great 'advertising sign', announcing that ions and electrons, transporting solar energy, are reaching their destination. What is less commonly realized is that during a spectacular auroral display the major fluctuations of luminous intensity can be closely correlated with the more violent oscillations of magnetic traces.

There still awaits discovery the cause of a class of minor magnetic storms, showing (unlike the great storms) a well-marked 27-day recurrence tendency, corresponding to one synodic solar rotation period. Their magnetic trace characteristics are also different from those of the great storms. A continuously emitted stream of particles radiating from a limited solar region might give rise to such effects as it periodically sweeps across the earth. Wulf and Nicholson[16] have recently produced evidence suggesting that ultra-violet light, emitted from patches of quiescent bright hydrogen on the sun, rather than a corpuscular beam, may be the active agent generating this type of storm. Since the matter is undecided, it focuses attention on the need for much fuller investigation than hitherto of chromospheric and ionospheric phenomena at times of sunspot minimum activity, when these recurrent storms are more easily studied than at other periods in the solar 11-year cycle.

What is the nature of the storm-generating particles and why have they not been detected before arrival on their one-day journey from the sun? Some years ago, Chapman suggested that the streams should be detectable spectroscopically, since they would cause anomalous absorptions in the Fraunhofer spectrum displaced to the violet by Doppler effect. Such absorption in the region of the *H* and *K* lines of calcium has been reported during magnetic storms by Richardson[17] from Mount Wilson and by Brück and Ruttlant[18] from Cambridge. In both instances, however, the magnitude of the observed result is so little greater than the errors inherent in the photometry that further confirmation is needed. At Sherborne and Edinburgh[5] the absorption effect has been sought for close to the $H\alpha$ emission during and shortly after the occurrence of the flare, when, according to Kahn's[19] recent theoretical investigation, the chances of detection are more favourable than later on. A small but definite asymmetry in the emission line has been established as a result of more than five hundred measures relating to ninety-nine different flares. It is found that near the time of peak intensity the blue wing of the emission is less extended than the red wing, suggesting absorption by hydrogen atoms in the 2-quantum state which at this time are in process of accelerating away from the flare region. Hydrogen is, of course, the most abundant element in the chromosphere. Moreover, the action of the Lyman α radiation from the flare will be to increase greatly the population of the 2-quantum state of hydrogen in the vicinity of the flare while it is in operation.

In the search to detect the storm-generating particles another characteristic flare phenomenon has been photographed at Edinburgh[5]. About 80 per cent of intense flares are known to give rise to thin jets of prominence material, consisting in the main of hydrogen and calcium atoms. These filaments are ejected with an initial velocity of about 200 km./sec. at the time of greatest intensity of the $H\alpha$ emission from a point in the chromosphere near the flare but not directly over it. They rise to a maximum height of the order of 100,000 km. before coming to rest and returning along the same (sometimes curved) trajectory. In Fig. 3*b* is shown the spectrum of the $H\alpha$ absorption line of one of these flare surges taken during its ascent near the centre of the sun's disk and exhibiting a Doppler displacement to the violet of 3 A., corresponding to a velocity component of 140 km./sec. in the line of sight. So far, in the many cases observed visually by Newton[20] and the author[21], there has been no evidence that any part of this *surge* material actually leaves the sun.

(ii) *Cosmic Radiation.* Variations in measured cosmic ray intensity associated with intense flares have been reported by Forbush[22], Ehmert[23] and others. In the great flare of July 25, 1946, for example, an increase of 15 per cent in cosmic ray intensity was recorded about *one hour* after the main burst of $H\alpha$ emission. The present rather meagre data do not allow any certain conclusions to be drawn as to whether these observed increases represent genuine emissions of cosmic ray particles from the flare regions, or merely arise from secondary flare effects of terrestrial origin.

Theoretical Approaches

The facts as we now see them present a tremendous challenge to the theoretical astrophysicists. For it is clear that we must study the flare problem no longer in its restricted solar sense, but in its wider application to the stars in general. The sun is a very average star—average in mass, luminosity and spectral type—and it is long odds, therefore, that any phenomenon of this nature which we find occurring to pattern in the solar chromosphere will also be reproduced in the atmospheres of many millions of other stars, appearing with much greater intensity in some and with lesser intensity in others.

Giovanelli, in a valuable theoretical discussion of flare formation[24], bases his electromagnetic ideas upon the development of induced electric fields in the vicinity of sunspots during the periods of most rapid growth and decay of the spot magnetic fields. At critical values of the electric field which he has calculated, he shows that electrons may gain energy from the field more rapidly than it can be dissipated in atomic collisions. Under such conditions, something analogous to a gigantic lightning flash takes place in the sunspot region. It may be said that there is a great deal of observational evidence in support of the mechanism which he proposes, though there are still many detailed aspects which await explanation.

Discussing the origin of the radio-frequency radiation from the galaxy, Unsöld[25] deduces that this must originate in stars of late type which show flare activity like the sun, only on a scale 10^{11} times as great. Assuming that such stars exist—and there are many features of the emission lines of M-type variables which are similar to solar flare spectra—he develops the hypothesis that cosmic radiation as a whole is the smoothed result of high-energy particle emissions from the flare mechanisms which are continuously and extensively active in the atmospheres of these stellar sources.

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SCIENTIFIC INSTRUMENTS AND APPARATUS

PHYSICAL SOCIETY'S ANNUAL EXHIBITION

IN his presidential address to the British Association at Brighton in September last, Sir Henry Tizard said, ". . . it is not the general expansion of research n this country that is of first importance for the restoration of its industrial health, and certainly not the expansion of government research, remote from the everyday problems of industry. . . . What is of first importance is to apply what is already known." In general, knowledge in the physical sciences, he remarked, now accumulates much faster than it can possibly be applied to industry. No new discovery, in any field, is likely to have so quick and beneficial an effect on British industry as the application of what is already known.

This point of view finds support in the Annual Exhibition of Scientific Instruments organised by the Physical Society. The thirty-third exhibition of this character was held at the Imperial College of Science and Technology, South Kensington, during April 5–8. It was formally opened by Prof. G. I. Finch, president of the Physical Society and chairman of the Exhibition Committee. On this occasion more than a hundred and fifty firms, research sections of government departments and trade associations were showing examples of recent developments in the design and production of scientific instruments and new techniques applying physical principles. As the president of the Physical Society pointed out, "The object of the Physical Society is to promote the growth and diffusion of a knowledge of Physics, and the Annual Exhibition, with its accompanying discourses and films, is one of the Society's activities directed towards this end".

Unfortunately, owing to structural alterations now proceeding at the Imperial College, it was necessary this year to reduce the space available for the Exhibition by about 30 per cent, which necessitated reducing the number of exhibits by roughly that proportion. An interesting departure from previous exhibition arrangements was to abolish the line of demarcation between "Trade" and "Research" exhibits. The number of visitors attending the Exhibition this year was about the same as last year, reaching a total of about 13,000. As before, the issue of tickets was restricted to avoid overcrowding.

On three occasions during the Exhibition, the film of the "Teleidoscope" or "Liquid Eidophor" was shown. The film demonstrates a recent development in cinema television equipment. The teleidoscope, developed under the direction of the late Prof. F. Fischer at the Federal Technical Highschool, Zurich, employs a novel means of picture production depending on the effects of electro-capillarity. A modulated cathode ray beam scans a raster upon a uniform liquid layer, the so-called 'eidophor', spread upon a revolving glass disk. Each point of the raster takes the form of a minute lens the curvature of which depends on the instantaneous charge impressed by the scanning beam upon the corresponding area of the eidophor liquid. The raster is resolved into a visible image using a Töpler schlieren system. The potential advantage of this system over the conventional cathode ray tube depends on the fact that it constitutes a true light valve, the light output of which is independent of the energy of the cathode ray scanning beam, an advantage which possesses great flexibility. The degree of picture 'storage' achieved by this system can be varied by appropriately adjusting the rate of leakage of the charges on the eidophor in such a way that the raster remains sensibly unchanged for the duration of each frame and is then electrically wiped out by the conductivity of the eidophor.

Three discourses were given during the Exhibition. The first of these, by Dr. J. A. Radcliffe, of the Cavendish Laboratory, Cambridge, was concerned with "Some Problems of Wave Diffraction in the Ionosphere". Simultaneous observations of radio 'fading' at two points indicate that radio waves are returned from the ionosphere by a process of diffractive reflexion as if from a rough surface. The diffraction effects produced by a simple model of this kind can be related to well-known phenomena of optical diffraction. Dr. Radcliffe showed that the methods of calculation are similar to those employed in the analysis of random fluctuations such as occur with radio 'noise'. The fading was shown to be produced by movements of the random irregularities in the ionosphere and is related to their turbulent or regular motions. It was shown how winds in the ionosphere can be measured, and how some of the observed radio effects are similar to well-known optical phenomena.

In the second discourse, Mr. A. J. Philpot, of the British Scientific Instrument Research Association, dealt with "Some Modern Aspects of Scientific Instruments". He directed attention to the fact that three factors have markedly affected the design of scientific instruments in recent years. In the first place, the field of use of instruments has greatly increased and extends to almost every sphere of human activity. The environment of the scientific instrument is no longer exclusively in the laboratory, and instruments of great precision are now to be found in everyday use in workshop and factory. In the second place, the users of instruments are no longer a specialist class, and only a small proportion are scientific workers. In these days of instrumentation, lay users of instruments probably outnumber the scientific users. Lastly, advances in science and the emergence of new branches of science, notably that of electronics, have given to the instrument designer new aids in the achievement of his purposes. Modern scientific instruments incorporate features which reflect these changing circumstances and take advantage of new techniques.

The third discourse, given by Prof. O. R. Frisch, of the Cavendish Laboratory, Cambridge, gave "A Review of the Methods and Instruments used in Energy Measurements on Particles emitted from Atomic Nuclei". A short discussion of the general phenomena of ionization and excitation of atoms, on which the detection of nuclear fragments is based, was followed by a description of ionization chambers, proportional and Geiger–Müller counters, liquid and crystal counters, and scintillation counters, together with a discussion of their respective merits, and of their suitability for energy measurement. Magnetic and electric deflector methods were considered also, in conjunction both with counters and with cloud chambers. Auxiliary equipment such as coincidence circuits, scalers, kick-sorters, etc., were briefly described.

The wide diversity of the exhibits is indicated in the "Handbook of Scientific Instruments and Apparatus 1949", containing more than 270 pages of descriptive matter and some sixty pages of trade advertisements. This handbook, which is well printed and illustrated on high-quality paper, forms not only a guide to the exhibits but also serves, as its title indicates, as a handbook of reference to present British achievements in scientific instrument design and manufacture. A visitor to the Exhibition was impressed not only by the wide diversity and novelty of many exhibits in electronics and atomic physics, for example, but also by the excellence and high quality in the design and construction of the more ordinary, or more familiar, types of scientific instruments. The latter are exemplified by a wide range of electrical measuring instruments, galvanometers, electrical bridges and test sets, resistors, voltage stabilizers, valve oscillators, recorders, colorimeters, densitometers, microscopes, photometers, photocells, spectrometers, ultrasonic oscillators, X-ray equipment and so on. While most of these are based on well-known physical principles, almost all of them embody up-to-date improvements in important details which make them more serviceable and reliable in the laboratory and workshop. In an age of electronics and atom physics, one is apt to overlook, for example, the importance of such an old friend as the laboratory balance; but the aperiodic balance of to-day is remarkable evidence of progress and is proof of the beauty and excellence of British instrument design and craftsmanship. A micro-chemical balance with a load capacity of 20 gm., a sensitivity of 0·001 mgm. (0·1 mgm. swings the pointer 100 scale divisions), and a short period of oscillation is a very fine achievement. The weight-changing mechanism of modern balances is a great improvement on the old method employing tweezers and a box of weights. Other interesting exhibits of a mechanical nature include an apparatus for producing and measuring accelerations of the order of 10^4–10^5 g; the measurement of the mechanical properties (hardness, work-hardening, elasticity and crumbliness) of cheese, these properties being related to the subjective judgment of cheese 'body' by experts; the 'sine' spring, a new mechanical device having a blade spring shaped like a sine curve, the stiffness of which can be varied continuously from positive through zero to negative values.

On the optical side, an interesting exhibit showed a low-power stereoscopic binocular microscope for use by aural surgeons while performing the fenestration operation. The illuminating system is duplicated so there is no risk of a breakdown during an operation. An optical device for metering the size of particles dispersed in a liquid uses a flat beam of light which, after passing through a layer of the dispersion, falls on a photo-cell and deflects a galvanometer. This gives a continuous indication of the extinction coefficient of the suspension at the sampling depth from which the particle-size distribution can be calculated. Two very good types of double-beam infra-red spectrometer were demonstrated, giving a direct record of percentage transmission as a function of wave-length. The Physical Society Optical Group provided a popular exhibit of curiosities in colour vision, demonstrating Benham's top, Bidwell's ghost and other phenomena associated with colour and the eye. Some very fine examples of electron microscopes were demonstrated, giving magnifications of the order 10,000–100,000 times. These beautiful instruments are now robust and simple to manipulate. Lead selenide cells were shown, capable of covering a range up to 5 μ at liquid-air temperature. A very impressive demonstration was staged by the National Physical Laboratory, using the isotopic mercury lamp, presented to the N.P.L. by the National Bureau of Standards, Washington. The lamp is an electrodeless tube containing pure argon at 3-mm. pressure and 3 mgm. of the isotope mercury-198, produced by neutron irradiation of pure gold. The little globules of this mercury isotope could be seen clearly in the tube. The extremely monochromatic quality of the radiation from the tube made it suitable for the direct measurement of end standards up to 40 cm. length. In acoustics, a low-frequency analyser, developed to the requirements of the Royal Aircraft

Establishment, Farnborough, indicated the sound spectrum of engine vibrations over a range 6–4,000 c./sec., covered in six octave bands. The scan for the six-channel bands is arranged to take place in 1/25 sec. A pulsed ultrasonic gauge was also shown which measures the velocity and attenuation of ultrasonic waves in liquids and gases. Ultrasonic cavitation and emulsification phenomena were demonstrated by means of magnetostriction-type oscillators. An interesting feature of the Exhibition was the increasing use of magnetic amplifiers. A number of these were shown in the amplification of D.C. signals, for example, in recording slowly varying temperatures indicated by a thermocouple. In another example the magnetic amplifier was used to operate at audio-frequencies. The germanium triode oscillator and amplifier, or transistor as it is called by the Bell Telephone Laboratories of the United States, was exhibited. It consists of a small block of germanium with two fine rectifier points placed close together on the surface, so that there is a transfer resistance between them. The input impedance is about 200–400 ohms, the output impedance being about 20,000 ohms, and power gains of the order of 20 d.b. can be obtained.

Owing to supply and other difficulties in the use of natural quartz for oscillator and resonator plates in telecommunications, synthetic quartz crystals are being developed. These are grown by a hydrothermal process using a natural quartz plate as a 'seed' crystal. In the atomic and nuclear field, electronic counters for use with Geiger–Müller tubes were shown to be capable of counting-speeds of the order of 10,000 per minute. A very interesting display of nuclear track photomicrographs was on view, the work having been done by Messrs. Kodak, Ltd., for the Atomic Energy Research Establishment at Harwell. Such a high sensitivity has been reached that the plates will record charged particles of very low ionizing power. Prof. O. R. Frisch demonstrated the application of a pulse sorter to the study of the energy distribution of particles resulting from nuclear disintegration. Each pulse causes a small steel ball to be propelled along an inclined plane with an initial speed depending on the size of the pulse. Each ball described a curved path and lands in one of thirty parallel grooves depending on the pulse height. The balls accumulating in the grooves form a histogram of the energy distribution.

These are but a few items selected almost at random from a most impressive display of modern scientific instruments. The Exhibition as a whole reflected a very healthy state of the industry. As in previous years, an exhibitors' meeting was held during the Exhibition to consider possible improvements in the organisation of future exhibitions. An important feature of the Exhibition which must be mentioned was the revival of the craftsmanship competition, arranged for youths in workshops and drawing offices in universities, research laboratories and in industry to submit specimens of their work. Some very fine examples of instrument construction and design were shown. It is to be hoped that the Physical Society will continue to encourage this feature of the Exhibition, as the future of the scientific instrument industry depends on high-quality craftsmanship.

The industry and the world at large owes a debt of gratitude to the Physical Society for the organisation of this valuable exhibition.

A. B. WOOD

OBITUARIES

Dr. Vladimir Tchernavin

DR. VLADIMIR TCHERNAVIN, born in Tsarskoe Selo in 1887, had lived in Great Britain pursuing his researches on fishes since 1934. He was a man willing to sacrifice more for his ideals of liberty and truth than most of us. At the age of twelve, on account of ill-health, he was sent from St. Petersburg to his grandmother at Omsk; all ailments vanished at Omsk, and the boy and his cousin spent long days with the nomadic tribes of the Siberian plains. The freedom and gaiety of the simple lives of these people made a permanent impression on young Tchernavin, which must have been reinforced as he grew to manhood by the liberal ideas that inspired the revolution of 1905. No wonder that after twelve years of service to the Soviet State he was accused in 1930 of "unproletarian psychology". His arrest was one of many that followed the failure of the first five-year plan, and he spent the next two years in a G.P.U. concentration camp.

Tchernavin's training in biology began informally, and at the age of eighteen he accompanied an expedition to western Mongolia as zoological collector. He travelled later as zoologist or fishery investigator in Mongolia, the Caspian region, Tian Shan, Bessarabia and the Far East. His early interest in fishes was centred upon the life-history of salmon, and he obtained his doctorate in ichthyology for work on structural changes in the salmon during its breeding migration.

Under the Soviets, Tchernavin lectured at the Agronomical Institute in Leningrad, and was later employed in administering the great fishery organisations of the Caspian and Murmansk. He spent long periods working under the rigorous conditions of the northern port. During his imprisonment, he was again employed in fishery work, in the organisations run by the G.P.U. His behaviour at this time was designed to gain the confidence of his gaolers, who gradually allowed him more liberty of movement. At last he was able to arrange to be sent on a fishery project to a place where he had arranged to meet his wife and little boy, and with them he escaped over the mountains into Finland. During this journey the experience gained in expeditions to wild places stood him in good stead. In Finland he wrote an account of his arrest and imprisonment, and Mrs. Tchernavin described the escape. These books, entitled "I Speak for the Silent" and "Escape from the Soviets", were translated into several languages.

At the outbreak of war in 1914, Tchernavin had been on holiday in London. He had hurried to Russia for mobilization, but retained such a favourable impression of London that after his escape it was here that he determined to settle. This he was enabled to do by the Academic Assistance Board (later the Society for the Protection of Science and Learning). With a grant from this organisation he returned to his beloved salmon work, perforce neglected for so many years, and published a series of papers on the life-history of salmon, demonstrating the nature of the changes in the skull during the breeding migration and the connexion between the magnitude of the changes and the size of the fish. Some of this had already been published in Russian during 1918–23, in journals unobtainable in Britain; but the whole was done again, with additional material and a more mature approach, and established Tchernavin as a research worker of high standard.

After this, Tchernavin worked for the British Museum (Natural History), and his first assignment was the collection of fishes made by the Titicaca Expedition of 1937. The taxonomic analysis of this rather uninteresting collection was given almost more than its share of meticulous labour by Tchernavin, who had, like all taxonomists, to cope with the shortcomings of his predecessors as well as with the limitations of his material. A museum analysis could scarcely go further, and this work will form a reliable basis for the study of ecological and genetic differentiation of these little fishes whenever someone finds it worth while. Tchernavin did not enjoy this work—nor the failure of the then editor of the Titicaca reports to appreciate it—and he accepted with great enthusiasm a suggestion that he should report on the oceanic fishes brought back by the "Discovery" expeditions. He took first the Stomiatoids, with the intention of studying the inter-relationships of the genera and families; but he became fascinated by the functional morphology of the head of *Chaulodius* and the movements involved in catching and swallowing prey. He soon found that current conceptions of the movements of the parts of the head and the fore part of the trunk in fishes were false or blurred, and he wrote the first account of these movements, both in the large-mouthed ocean predators and in familiar fishes like the salmon and cod, carried as far as morphological analysis may go. The largest of these works, beautifully illustrated by Tchernavin himself, is now in the press for publication as a separate monograph by the Museum.

In October last he learned that his best friend during recent years was fatally ill. He abandoned his work at the Museum the better to care for her, and although his devoted nursing prolonged her life five months beyond medical expectation, he took his own life on March 31, the day following her death. Many weeks previously he had left the notes for this obituary among his papers where some colleague would eventually find them.

ETHELWYNN TREWAVAS

Prof. H. B. Kirk

Two or three years before his retirement, when a bronze plaque and tablet were erected in honour of Harry Borrer Kirk, emeritus professor of biology, Victoria University College, Wellington, New Zealand, the tributes paid by different generations of his colleagues and students showed the profound affection harboured everywhere for that kindly and companionable soul. He was an inspiring friend, of an old-world cultured courtesy, quietly spoken, gently satirical on occasion, subtly humorous, but possessed of a strength of character which could make itself felt to some purpose—respecting his neighbours as he respected himself. He devoted his life to his students, and the effectiveness of his technique was mirrored by the high proportion of biology scholarships and honours won by his students year after year without intermission.

Prof. Kirk was born in England in 1859, and went to Auckland, New Zealand, in 1863. His father, Thomas Kirk, the New Zealand botanist, was born in Warwick and educated at Coventry, where, in 1850, he married Sarah Mattocks of that city. Prof. Kirk's elder brother, Thomas William Kirk, became prominent in New Zealand as the founder of the Government biological and horticultural departments; thus those two brothers had a far-reaching influence in pioneering the biological services of the Dominion, the elder in the applied and the younger in the academic field.

As a pupil at the Auckland Grammar School and at Wellington College, Prof. Kirk stood high in classics, modern languages, mathematics and science. There being no university college yet established in Wellington, he graduated as an extra-mural student of the University of New Zealand, and in 1883 secured M.A. with honours in zoology and botany. At that time he was employed in the Education Department, where he rose to be assistant inspector of native schools; during the twenty-four years so occupied, he made full use of his travels to study the biology of the country and to understand humanity in all walks of life. In 1903, when he was appointed to the chair of biology at Victoria College, Wellington, as the first professor, he was well equipped for the magnificent work he was to carry on for forty years. There were no laboratories at the outset, and he commenced work in a single room of a kindergarten school at Thorndon, which was available only at night; but by his efforts there arose from that modest beginning the extensive and modern biology block of Victoria College; he lived to see this erected and to occupy it for some years until failing eyesight but not spirit, put a period to his active career. He retired in 1944, and died at Hamilton on July 15 1948, aged eighty-nine years.

DAVID MILLER

Mr. R. A. Todd

THE death of Mr. R. A. Todd, coming so soon after that of Prof. Walter Garstang, has broken yet another link with those pioneer marine biologists at work at the opening of the present century. He was the eldest son of Mr. and Mrs. H. S. Todd, of Norwich where he was born in 1877; educated at Paston Grammar School, North Walsham, he graduated at the University of Leeds. It was in 1898 that Todd joined the staff of the Plymouth Laboratory of the Marine Biological Association as the director's assistant. The director was E. J. Allen, and the only other member of the scientific staff was Garstang who was naturalist in charge of fishery investigations

In those early days one of the first needs was to build up a knowledge of the marine fauna in the Plymouth neighbourhood, and Todd was well fitted for the purpose. He was an able and enthusiastic naturalist, and his name will always be linked with that of Allen in the reports of their well-known surveys of the Exe and Salcombe estuaries. Independently, Todd published an account of the invertebrate fauna of the bays between the Start and Exmouth, and to this day the "Plymouth Marine Fauna" is liberally sprinkled with his initials recording observations on many invertebrates.

In 1902 Todd was transferred to the laboratory at Lowestoft to assist in the international investigations in the North Sea which the Association was undertaking on behalf of the British Government. Here his faunistic knowledge proved invaluable and enabled him to produce his reports on the food of fishes which form the basis of our present knowledge. In 1910 the Lowestoft laboratory was transferred under the Board of Agriculture and Fisheries, and Todd remained there until 1912, when he joined the Fisheries Department as an inspector. In 1920 he was appointed a district fishery officer and returned to Plymouth and the south-west. In this work his scientific experience of the fishing industry and its methods, and his knowledge of the habits of fishes, made him a valuable adviser. He retired from service in 1937, but was temporarily re-employed from the outbreak of war until the beginning of 1944.

Todd had great charm, and will be especially remembered as a kind friend by members of a younger generation on the staff of the Plymouth Laboratory whom he and his wife made so welcome at their home in Elburton, outside Plymouth. Here he was always most anxious to discuss problems of natural history, and to the end he took a lively interest in the work of the Laboratory at which he started his scientific career. He passed away without suffering after a long illness patiently borne, and the sympathy of his many friends will be extended to Mrs. Todd in her bereavement. F. S. RUSSELL

WE regret to announce the following deaths:

Dr. F. S. Locke, formerly reader in physiology at King's College, University of London, on May 5, aged eighty-three.

Count Maurice Maeterlinck, philosopher and naturalist, on May 6, aged eighty-six.

NEWS and VIEWS

University of Nottingham: Installation of the Chancellor

FULL university status was conferred on University College, Nottingham, by the King in Council on July 9, 1948 (see *Nature*, August 14, p. 240); Lord Trent was installed as chancellor of the new University on May 4, 1949. It was a day of magnificent pageantry, and the occasion was described by the great historian, Dr. G. M. Trevelyan, as truly historic. The long procession included representatives of seventeen foreign universities and of eighteen British and Commonwealth universities and university colleges, members of the University Grants Committee, students and staff of the University of Nottingham, the Lord Mayor of Nottingham, and the mayors of neighbouring towns. The vice-chancellor (Mr. B. L. Hallward) opened the meeting and called upon the senior pro-chancellor (the Duke of Portland) and the registrar to lead in the Chancellor. As the Chancellor's procession entered the hall, preceded by the mace-bearer in colourful costume, it was greeted by a fanfare of trumpets. On reaching the platform, the Chancellor was installed by the Duke of Portland, who delivered an address of welcome; he was followed by representatives of other universities. Then Lord Trent received the University's first honorary degree, that of doctor of laws. In returning thanks, Lord Trent described a university "as a seat of learning at which the habit of exact thinking is inculcated and the quest for truth is pursued for its own sake. It is in this sense that our University must be judged as a training ground for future leaders, at every level, of science, and of the arts and professions. The most important factor in industry to-day is the human one. Technical ability is not enough without leadership and vision, and to my mind the best training for these qualities is a course in the humanities."

The remainder of the ceremony consisted in the conferment of honorary degrees on Lord Macmillan, Lord of Appeal, Dr. G. M. Trevelyan, Sir Walter Moberly, chairman of the University Grants Committee, and Mr. E. W. Hives, the eminent engineer who is managing director of Rolls-Royce. The public orator, Prof. W. J. Sprott, introduced the graduands, mixing well-deserved praise with occasional gentle thrusts of humorous raillery. Lord Macmillan, in reply, emphasized the relation of a modern university to commerce and industry. He also referred to the long and fruitful association of Nottingham University College with the University of London, of the Court of which he was for many years chairman. Dr. Trevelyan pointed out that Oxford and Cambridge are nearly at saturation point in numbers. If university expansion on a large scale is to take place, it should take place chiefly in the newer universities. "It must be an inspiring thing to belong to the newest University, so splendidly situated and equipped, in these days when the tide is with you and the future of things academic is so full of value and promise." At a luncheon held at the University before the installation, Sir Walter Moberly, toasting the University, said the auguries for its future were good. It had the support of the authorities and the people not only of the city but of the whole region; it had a home and setting which must be the envy of most universities in Britain and the beauty and dignity of which must be an inspiration to all who entered it; it had already given evidence that it could produce men who had made distinguished contributions to scholarship and who had a high, austere ideal of knowledge.

University of Malaya

THE University of Malaya, created by local legislation enacted in March and April, is the youngest university in the British Commonwealth. Its basis is the fusion of the King Edward VII College of Medicine (1905) and Raffles College (1928), in accordance with the recommendations of the Commission on University Education which, under Sir Alexander Carr-Saunders, visited Malaya in 1947. For some years the University will use the buildings and grounds in Singapore of the two constituent colleges, but hopes soon to begin to erect completely new accommodation on an as yet undeveloped site on the mainland. His Majesty's Government has promised £1,000,000 towards the building fund. The chancellor, Mr. Malcolm Macdonald, has launched an appeal for contributions to an endowment fund. The first vice-chancellor is Dr. G. V. Allen, formerly principal of the College of Medicine. The Faculties of Arts (including social studies), Science and Medicine (including dentistry) will continue the teaching work of the two colleges and will shortly be developed to include departments of Chinese, Malay and Tamil studies. Among the research activities connected with the University are an Ionospheric Research Station, staffed and financed by the United Kingdom National Physical Laboratory, and a Tropical Research Unit, investigating the physiological and psychological effects of a tropical climate, staffed and financed by the Medical Department of the Royal Navy and the Medical Research Council.

Sir George Beilby Memorial Fund: Award to Dr. A. S. C. Lawrence

The administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made an award from the Fund for 1948 of one hundred and fifty guineas to Dr. A. S. C. Lawrence, in recognition of his research work in colloid science with special reference to lubrication and fuel oils. Dr. Lawrence was born in London and educated at Christ's Hospital; in 1920 he became junior lecturer and research assistant at the Royal Institution, first to Sir James Dewar and in 1924 to Sir William Bragg. Later he worked at Cambridge in the Department of Physical Chemistry and also in Prof. E. K. Rideal's newly formed Laboratory of Colloid Science, where he remained until 1942 investigating various aspects of anomalous viscosity, including joint work with Dr. J. Needham on myosin, and on solubilization and related topics. A long investigation was made of soap–oil systems during this period for the Fuel Research Division of the Department of Scientific and Industrial Research. In 1939, researches on coal-in-oil suspensions and on coal tar were carried out for the Fuel Research Station. In 1942, Dr. Lawrence went to the Imperial College of Science and Technology, London, as head of the research team of the joint Admiralty and Ministry of Supply advisory service on lubrication. In 1943 he worked on de-icing ships; later he carried out researches on emulsions of sea water in fuel oil and related problems, including investigations in port areas and in H.M. ships, and eventually became advisor on fuel oil to the Engineer-in-Chief, Admiralty. In 1947 he was appointed senior lecturer in chemistry in the University of Sheffield, a post which he now holds. Dr. Lawrence is the author of numerous papers, mainly dealing with colloids, published in the *Proceedings of the Royal Society* and other journals.

Archæological Discoveries in Moravia

Excavations at Věstonice in South Moravia were resumed in 1948, and Czechoslovak archæologists have already made noteworthy progress in revealing what has been described as a "diluvial Pompeii, preserved not by a downpour of volcanic ash but by the slow accumulation of a blanket of loess". About 30,000 years ago, hunters of mammoths dwelt in settlements along the route of animal migration through the Moravian Gap. These people not only attained skill in the chase, but also possessed considerable artistic talent. There is also evidence that they could count. More objects have recently been added to the collections of worked bones, skulls, utensils and plastic figures that had accumulated from pre-war excavations. The first discovery was that of the remains of four mammoths, each of which is estimated to have weighed eight or ten tons. In what was a human settlement, a plastic model, two inches long, of a woman's head has just been unearthed. It is not so striking as the model, five inches high, known as the Věstonice Venus (*Nature*, **131**, 607; 1933), though it is of great interest on account of its age. A well-preserved baked clay model of a bear has also been discovered as well as a curious whistle, which still functions, made from a mammoth's bone. Photographs of these objects, and an account of them by Dr. Edvard Cenek, was given in a recent issue of the Prague illustrated weekly *Svět v Obrazech*.

Research in Travancore during 1939–46

The University of Travancore Department of Research Report for the Septennium 1939–1946 (pp. ix+594; Trivandrum, 1948) is an admirable illustrated record, as non-technical as possible, of the activities of the Department during the period. It is intended also as a basis of review on which future developments may be planned. The first part briefly reviews the history and organisation of the Department since its institution in 1937. The second part describes the organisation and activities of the Central Research Institute and of its several divisions of applied biology, applied chemistry, marine biology and fisheries, preventive medicine and statistics, and the observatory. The third part deals with the work of the University College, the Institute of Textile Technology and the College of Engineering, while among the appendixes is a list of research publications of the Department for 1939–46. Most of the research in this report deals with the application of science towards the study and utilization of the local crops, industries and resources of Travancore, and the work of the Department covers a very wide field.

The Flamingo

A recent issue of *British Birds* (41, No. 12; December 1948) contains a selection of a remarkable series of photographs of flamingos (*Phœnicopterus ruber*), taken by G. K. Yeates, W. E. Higham, T. W. B. Jeans and H. A. Patrick in the Camargue (Rhone delta) in May 1948. Until recently it has been doubtful whether the Camargue could be regarded as a breeding-place of flamingos; but in June 1948 a large breeding-colony in a remote locality was 'discovered' by Yeates, Higham and Patrick. The locality appears to be the one in which flamingos most frequently breed, or attempt to breed, in the Camargue. When the photographs were taken, a large number of birds, estimated at approximately three thousand pairs, were breeding. In remarkable contrast to their sensitivity in the earlier stages of breeding, when they desert with great readiness, the birds are surprisingly approachable when the young are hatched. The nests are formed of mud scraped up by the birds to form a mound. They are usually made in shallow water and are raised until they are a few inches above water-level, although frequently the water afterwards drops, leaving them high and dry.

Fauna of Australia

An article by A. S. Le Souef in the *Journal of the Society for the Preservation of the Fauna of the Empire* shows how the impact of civilization has altered the fauna of Australia. Over the last 150 years, introduced mammals like the fox, rabbit, hare, cat, pig, black rat and common mouse have spread through the bushlands and are rapidly ousting the native marsupials and terrestrial birds. Already several species of wallabies, rat kangaroos, bandicoots and the marsupial wolf either are, or are on the verge of becoming, extinct. This is particularly so in the open districts of the southern half of the continent, and the Commonwealth Government is now considering the establishment of a fauna park in the vicinity of Canberra. The unique lyre-bird is reported to be holding its own against the fox and the cat; but the striped marsupial wolf may already be extinct. The article also contains an account of the effect of disturbances of the native fauna on general biological relationships.

Two Indian Plant Diseases

THE issue for June 1948 of the *Proceedings of the Indian Academy of Sciences* (**27**, B, No. 6) contains two contributions to the phytopathology of southern India. M. S. Balakrishnan (pp. 161–173) describes a new species of *Pythium* (*P. indicum*), causing a fruit rot of *Hibiscus esculentus*. The fungus has filamentous sporangia, the typical sexual reproduction of *Pythium*, and has a wide host-range, including maize and *Petunia*. K. V. Ramakrishnan (pp. 174–193) has studied isolations of *Piricularia* from four host species —*Oryza sativa*, *Eleusine coracana*, *Setaria italica* and *Digitaria marginata*. No difference in morphology has been found between the four isolates; but their physiology varies somewhat, particularly in the width of host-range, the most favoured sources of carbon and nitrogen, the optimum temperature, and the enzyme status.

Earthquakes during February 1949

SIXTEEN strong earthquakes occurred in the world during February. The strongest and deepest was probably that which occurred on February 2 from a focus some 200 km. deep beneath the Aleutian Islands. This had strength 7½ on the instrumental scale. The next most intense was probably that on February 13 (strength 7) from the Kermedec Islands region. The shock, however, which gave the greatest amplitudes at Durham (500 μ) occurred on February 23, from an epicentre, according to E. Peterschmitt and P. Baltenberger, of Strasbourg, in the Tien-Sehan highlands (latitude 42½° N., longitude 84° E.) and had strength 6¾. The earthquake on February 5 with epicentre near latitude 40° N., longitude 30° E. in Anatolia was felt at Eskishir, Kütahya, Bozüyük and Bursa, and destroyed property in the epicentral region. European earthquakes occurred on February 3, 17 and 19 in the Karnische Alps (felt in Frioul, Italy), in the Basses Alps (Barcelonnette) and south-west of Winterthur, respectively. The earthquake of February 28 occurred in the region of the Sandwich Islands in the South Atlantic Ocean. Movement during the month appears to have been confined to the well-established seismic zones on the earth. Instrumental reports have been received from the central stations of the United States Coast and Geodetic Survey (in co-operation with Science Service and the Jesuit Seismological Association), Strasbourg and Zurich, and from individual stations at De Bilt (Netherlands), Durham, Stuttgart, Toledo and Uccle (Belgium).

New Zealand State Scholarships for Science Graduates

SIX national research scholarships given annually to science graduates by the Government of New Zealand on the recommendation of the Council of Scientific and Industrial Research have been awarded to the following: Mr. J. H. Brown, of Auckland University College, for research in biochemistry with a medical and endocrinological bias, the award being tenable at the Courtauld Institute of Biochemistry, Middlesex Hospital, London; Mr. R. H. Thornton, of the Canterbury Agricultural College, for research in soil microbiological techniques, the award being tenable at Rothamsted Experimental Station, or the Macaulay Institute for Soil Research, Aberdeen, or Department of Agriculture, Canada, whichever is available; Mr. R. N. Brothers, of Auckland University College, for research in sedimentary petrology; Mr. P. G. Harris, of Victoria University College, Wellington, for research in geochemistry; Mr. W. B. Taylor, of Auckland University College, for research in statistics and statistical methods; Mr. C. B. Speedy, of Canterbury College, Christchurch, for research in light-engineering electronics. Each scholarship has a tenure of two years and a value of £250 a year with additional grants for books and university fees. They may be used at approved university colleges in New Zealand and elsewhere; but where facilities are available in New Zealand, every encouragement is given for the courses to be undertaken in the Dominion.

British Scientific Instrument Research Association

ON March 25 the British Scientific Instrument Research Association moved from 26 Russell Square, London, W.C.1 (now required by the owners, the University of London), to new headquarters at 17 Princes Gate, London, S.W.7. The March issue of the *Bulletin* of the Association records that the Russell Square premises were first occupied in November 1918, and that, from that date until October 1946, when the new laboratories at 'Sira', Chislehurst, Kent, were opened, the laboratories and all the activities of the Association were housed at Russell Square. Since the occupation of the new laboratories, the Russell Square premises have been the headquarters of the Association, the home of the Information Department and of the Optical Computing Department, and more recently also the offices of the Scientific Instrument Manufacturers' Association.

Conference on Electron Microscopy at Delft

DURING and since the War, a very active school of electron microscopy has grown up in the Technical University of Delft, under the direction of Dr. J. B. Le Poole. In addition to furthering the applications of the instrument, his work on its technical improvement has been of great importance, and has led to the development of a commercial model by the Philips concern. In view of Dutch interest in this field, the Applied Physics Section of the Netherlands Physical Society is arranging a Conference in Electron Microscopy, which will be held at Delft during July 4–9. Its intention is to bring together specialists from other European countries and from America, to which end an international sponsoring committee has been set up. Both this and the working committee are under the presidency of Prof. H. B. Dorgelo, Technical University, Delft. A programme has been arranged, covering all the main technical aspects and applications of the electron microscope. In each session the opening paper is to be given by an invited speaker, followed by short contributions from others. The chief topics are: image formation and contrast (E. G. Ramberg, Radio Corporation of America), preparation techniques (D. G. Drummond, Shirley Institute, Manchester), resolving power and apparatus (M. E. Haine, A.E.I. Research Laboratories, Aldermaston). The general lecture on microscopes will be given by Dr. Le Poole, and that on applications by Prof. W. T. Astbury. Accommodation is being found in Delft and The Hague by the working committee, and party travel at reduced rates is being arranged from Great Britain. Application forms for accommodation and travel can be obtained from Dr. V. E. Cosslett, Cavendish Laboratory, Cambridge, to whom offers of contributed papers from Britain should also be sent, as early as possible.

Royal Society of South Africa: Officers for 1949

The following have been elected to the Council of the Royal Society of South Africa for 1949: *President*, Dr. J. Jackson; *Honorary General Secretary*, A. J. H. Goodwin; *Honorary Treasurer*, J. G. Rose; *Honorary Editor of Transactions*, Prof. F. Walker; *Honorary Librarian*, Prof. E. Newbery; *Other Members of Council*, Prof. R. S. Adamson, Prof. E. Batson, Prof. B. L. Goodlet, J. J. Hewitt, M. R. Levyns, Dr. B. F. J. Schonland, Prof. C. J. van der Horst, B. de St. J. van der Riet and C. L. Wicht.

Society for General Microbiology: Officers for 1949

At the annual general meeting during April 20–21 of the Society for General Microbiology, the following were elected officers for the coming year: *President*, Prof. J. W. McLeod; *Honorary Treasurer*, Mr. H. J. Bunker; *Honorary Secretaries*, Dr. J. G. Davis (General), 35 Villiers Road, Southall, Middlesex; Dr. W. E. van Heyningen (Meetings), Sir William Dunn School of Pathology, University, Oxford; *Members of Committee*, Dr. L. A. Allen, Dr. C. H. Andrewes, Mr. F. C. Bawden, Dr. S. T. Cowan, Prof. A. W. Downie, Mr. L. D. Galloway, Dr. D. W. Henderson, Dr. R. Lovell, Prof. H. B. Maitland, Dr. P. M. Frances Shattock, Prof. Wilson Smith and Dr. D. D. Woods, with Sir Alexander Fleming, representing the International Association of Microbiologists; *Editorial Board*, Dr. B. C. J. G. Knight and Dr. A. A. Miles (hon. editors), Dr. G. C. Ainsworth, Prof. W. B. Brierley, Dr. T. Gibson, Dr. A. T. R. Mattick, Dr. K. M. Smith, Dr. A. W. Stableforth and Dr. D. D. Woods (associate editors).

Colonial Services Appointments

The following appointments in the Colonial Service have been announced: W. H. Edwards, agricultural officer, Nyasaland; P. Bannister, veterinary officer, Northern Rhodesia; J. L. N. McCulloch, veterinary officer, Gold Coast; M. R. Woulfe, veterinary officer, Tanganyika; C. Ginsberg, veterinary officer, Kenya; J. R. Curry (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; A. P. McWilliam (agricultural officer, Trinidad), agricultural officer, Sierra Leone; A. D. Combe (senior geologist, Uganda), assistant director of geological surveys, Uganda; W. Pulfrey (senior geologist, Kenya), chief geologist, Kenya; F. W. Aston (senior veterinary officer, Kenya), deputy director of veterinary services, Gold Coast; P. D. L. Guilbride (veterinary officer, Jamaica), senior veterinary officer, Jamaica; R. A. Hutchinson (veterinary officer, Gold Coast), senior veterinary officer, Gold Coast; J. B. Randall (veterinary officer, Uganda), deputy director of veterinary services, Uganda; G. H. Swynnerton (game ranger, Tanganyika), senior game ranger, Tanganyika.

"Maintenance of Nocturnal Ionization"

Referring to the communication under this title published in *Nature* of March 26, p. 491, N. C. Gerson writes: The material immediately after equation (8) should be replaced by:

The above equation on simple quadrature becomes for the F_2-ionospheric layer, assuming the latter to be an isobaric surface,

$$1/n = (\alpha_0/f) \exp(-ft) + k_1 \exp(-2ft). \qquad (9)$$

This equation is quite distinct from that describing the electron disappearance at the geometric surface of 300 km., namely,

$$1/n = -\{\alpha_0/2f(g + 1/2)\} \exp(-ft) + k_2 \exp(2fgt). \qquad (10)$$

The diagram as printed is correct, and was taken from equation (9) as given above. The legend should be corrected accordingly.

Announcements

The Makdougall–Brisbane Prize for the period 1946–48 has been awarded by the Council of the Royal Society of Edinburgh to Dr. Mowbray Ritchie, Department of Chemistry, University of Edinburgh, for his papers on thermal diffusion published in the Society's *Proceedings* during the period of the award.

Honorary associateships of the Birmingham Central Technical College have been conferred on the following: Sir Arthur Smout, director of Imperial Chemical Industries, Ltd.; Mr. J. J. Gracie, general manager of the General Electric Co., Ltd., Engineering Works, Witton; Mr. J. A. Hunt, general manager of the Hymatic Engineering Co., Ltd.; Mr. F. W. Lawton, Midlands divisional controller, British Electricity Authority; Dr. W. Wilson, manager of the Development Laboratories of the General Electric Co., Ltd., Witton; Dr. H. B. Keene, sometime head of the Department of Mathematics and Physics of the Birmingham Central Technical College; and Mr. Thomas H. Essery, sometime head of the Engineering Design Section of the Birmingham Central Technical College.

On May 17, the bicentenary of the birth on that date in 1749 of Edward Jenner will be marked by the opening of a comprehensive exhibition of Jenner manuscripts and relics at the Wellcome Historical Medical Museum, 28 Portman Square, London, W.1, arranged by Dr. E. Ashworth Underwood, director of the Museum.

Mr. C. G. Conway, of the Mond Nickel Company, known for his work on the development of high-temperature materials, and particularly the Nimonic alloys, has been appointed to the technical staff of Power Jets (Research and Development), Ltd.

The University of California Medical School will be holding a postgraduate course on the medical aspects of nuclear energy at the Medical Center, San Francisco, during August 29–September 3. The chairman of the course will be Dr. Joseph G. Hamilton, director of the Crocker Laboratory, University of California. Full details of the programme, fees, etc., may be obtained from Dr. Stacy R. Mettier, Head of Postgraduate Instruction, Medical Extension, University of California Medical Center, San Francisco 22, California.

The Supplementary List of Titles 1947–1948, issued by the National Research Council of Canada, December 1948, contains only the titles of publications in the series N.R.C. Nos. 1413–1799. It replaces the bi-monthly "Additions to the Publications" that have been issued since the second edition, 1947, of "Publications of the National Research Council of Canada", N.R.C. No. 1638. The bi-monthly "Additions to the Publications" are being issued again from January 1949. Requests for copies of publications listed should be addressed to the National Research Council, Ottawa, Canada.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Concerning New Elementary Particles in Cosmic Rays

An analysis of the composition of cosmic rays at an altitude of 3,250 m. above sea-level (Alagez) which we carried out in 1946 revealed the existence of a noticeable number of particles with masses exceeding that of the meson. This result was obtained by applying a direct method of determining the mass of fast particles, according to their deflexion in a magnetic field and their range as found by absorption experiments. It was shown that almost 10 per cent of the particles of the cosmic rays have masses lying between 250 and 2,000 electron masses. These results were published in Russian in December 1946 [1] and in English in January 1947 [2]. We suggested calling this group of elementary particles 'varytrons', stressing in this way the diversity of masses of the new particles. A month later, in February 1947, in an article in English[3], we presented some evidence which proved that there exist in the cosmic rays positive and negative particles which are heavier than the proton, their masses being as high as 5,000 m_e. All these results were also published in Russian in the *C.R. (Doklady) of the Academy of Sciences of the U.S.S.R.*[4] and in more detail in June 1947 [5].

By using a completely different method, S. J. Nikitin of the same laboratory showed that at least three groups of particles with masses larger than that of those commonly observed could be detected in cosmic rays. By measuring the specific ionization of the particles in argon, Nikitin found that the masses of the new particles group around values of 300–500, 700–1,100, 2,000–3,400 m_e. This investigation was also published in February 1947 [6].

As far back as the summer of 1947, by using a large permanent magnet with field strength of 7,500 gauss, we were able to increase considerably the dispersion of our mass-spectrometer. As a result we were able to resolve in greater detail the mass spectrum of the varytrons, and lines with sufficiently distinct edges could be distinguished; these lines yielded mass values of 200, 250, 330, 500–600, 950, 2,200, 3,400, 8,000 and 20,000 electron masses. These results were published in November 1947 [7].

In *Nature* of October 4, 1947, that is, about ten months after the publication of our first papers, Lattes, Powell and Occhialini[8] announced that they had observed eleven meson tracks in a photographic plate with thick emulsion which, after coming to rest in the plate, disintegrated with the emission of a secondary meson. The ratio of the masses of the primary and secondary mesons was estimated to be 2 : 1. Since they were unable to determine the mass of the primary as well as that of the secondary mesons, this result showed that there are at least two types of mesons, one of which is heavier than the other. Proof of the existence of particles heavier than the meson, however, was presented by us at a considerably earlier date, though no reference was made to this by Lattes, Powell and Occhialini.

We wish to emphasize here that our method is a *direct* method of determination of mass based on the measurement of momentum and range of the particles; moreover, at present it is the only method capable of resolving the complex mass spectrum of the cosmic ray particles. The reliability of our method is seen from the fact that the results published by Lattes, Powell and Occhialini confirm our results.

Lattes, Powell and Occhialini determined the mass of the primary meson ('π-meson') on the assumption that the mass of the meson product equalled 200, which thus leads to the value 400. We should like to point out that in view of the large diversity of varytrons which we have observed, such estimations may lead to erroneous results. Up to the present we have detected mesons with the following masses: 110, 140, 200, 250, 300, 350, 450, 550, 680, 850, 1,000, 1,300, 2,500, 3,800, 8,000 and approximately 25,000 [9]. Since Lattes, Powell and Occhialini could not measure directly the mass of the secondary mesons, they could not distinguish between masses of 140 and 200, and therefore the determination of the mass of the primary meson could not be carried out with any degree of certainty.

A note by Rochester and Butler appeared in *Nature* of December 20, 1947 [10], in which two cloud-chamber photographs were reproduced. On the basis of these photographs the authors concluded that there exist particles which are heavier than the usual meson and which decay spontaneously. The two cases observed by Rochester and Butler are obviously insufficient to permit one to draw such fundamental conclusions. However, in view of our work and the work of Lattes, Powell and Occhialini, such a conclusion seems plausible. Rochester and Butler also do not mention our work, although they express their thanks to Prof. P. M. S. Blackett, who, we had thought, would know of our results.

Finally, in *Nature* of April 10, 1948 [11], Powell and Occhialini again discuss their results obtained with thick photographic emulsions, and again no mention was made of our work.

A. I. Alichanian
A. I. Alichanow

Academy of Sciences of the U.S.S.R.,
Moscow.

Sept. 23, 1948 [recd. Feb. 7, 1949].

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I first learned of the results of the experiments referred to by Prof. Alichanow and his colleagues in conversations with Dr. A. Rogozinski during a visit to Paris in May 1948. Although I had not, at that time, seen their original papers, I made reference to their work in a lecture which I gave to the French Physical Society during the course of this visit, and in the account of the lecture which appeared afterwards[1]. In later publications, my colleagues and I have referred to Prof. Alichanow's work in so far as this seemed to us to be appropriate[2]. I had hoped that Prof. Alichanow would be able to accept an invitation which we had extended to him to attend the Bristol Symposium on Cosmic Rays in September 1948, and thus to have the benefit of personal discussions with him. These anticipations were not realized, however, and I therefore hope that the explanation given above makes it clear that the failure of my colleagues and I to make any earlier comment on these experiments was not due to any ill-will on our part—or of any desire to ignore the results of our Soviet colleagues—but was a consequence of the difficulties of communication and intercourse between us which exist at the present time.

I believe that similar difficulties are likely to occur in the future unless steps are taken to remedy this situation, and for this purpose a series of fully representative international conferences on cosmic radiation and other subjects would be of great advantage. As a second step, it would be of considerable assistance to physicists in Britain if reliable translations of important papers in Russian could be made available, with a minimum of delay, to interested workers in different fields of study. The responsibility for such translations could, perhaps, be undertaken by one of the learned societies.

In the space of a short letter, I can only comment briefly on the conclusions to which Prof. Alichanow and his colleagues have been led as a result of their experiments. There is now a large body of evidence[3] which establishes the fact that there exist in cosmic radiation two types of mesons, referred to as π-mesons and μ-mesons, of mass 286 ± 3 m_e and 216 ± 4 m_e, and with life-times $\sim 10^{-8}$ sec. and $2{\cdot}2 \times 10^{-6}$ sec., respectively. A π-meson is produced in the collision of a fast nucleon with a nucleus, and a positive particle of this type decays spontaneously to produce a μ-meson and some form of neutral particle.

Apart from the work of Prof. Alichanow and his colleagues, the only evidence for the existence of other types of mesons is derived, so far as I know, from a number of individual photographs, each of which has been interpreted as corresponding to a mode of decay of a meson of greater mass than a π-particle, but no two of which represent the same process. Particles of these types are certainly very rare compared with the π-mesons. The question of the existence of many types of mesons, of sufficient stability to pass through an apparatus of the type employed by Prof. Alichanow and his colleagues without having a high probability of suffering spontaneous decay in flight, is of great importance. The results of their further experiments, made desirable in order that the statistical fluctuations associated with their observations may be substantially reduced, should furnish a decisive answer to this question and will be awaited with great interest.

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[2] Brown, Camerini, Fowler, Muirhead, Powell and Ritson, *Nature*, **163**, 47 and 82 (1949).

[3] See, for example, Powell, "Properties of the π- and μ-Mesons of Cosmic Radiation", Report of the Bristol Symposium, 1948, for a general review of the subject and references to the literature (to be published shortly).

Tendency Towards Symmetry in Fundamental Physical Structures

THE symmetry properties hitherto used in physics mainly relate to existing geometrical symmetry or formal mathematical equivalence. Less attention has been paid to the one-way *tendency* towards higher symmetry in three-dimensional space, which marks many isolated processes ending in a stable end state. The fact that equilibrium states often possess elements of spatial symmetry or regularity (for example, bubbles, crystals, some atoms, molecules, etc.) may at first sight appear trivial. Yet much is to be gained if geometrical relations such as three-dimensional symmetry and asymmetry can be substituted for physical quantities such as 'structural potential energy', since they are simpler, more general, and closer to what is observed.

No analysis appears to have been made of the systems with equilibrium states possessing special symmetry elements, though the association of stability with symmetry has long been noted. Mayer[1] regarded instability as due to differences, which he called 'forces'. Mallard[2] observed, in relation to crystallization: "Cette tendance vers la symétrie est une des grandes lois de la nature inorganique". Mach[3] said, "there is no reason to be astonished that forms of equilibrium are often symmetrical" (in mechanical and fluid systems). Koehler[4], following Curie[5], suggested more generally that "in an isolated process asymmetries disappear as a constant state is approached". But these ideas have not been clarified or related to recent theories.

The tendency towards three-dimensional symmetry (or minimum asymmetry) in fundamental micro-structures is obscured by the masking effect of thermal disorder, by mathematical methods which emphasize higher formal equivalence and tend to neglect three-dimensional spatial symmetry, and by the fact that when conservation principles and reversible laws are used, the one-way character of the actual phenomenon is ascribed either to initial conditions or to probability effects. Moreover, the mathematical concept of symmetry requires generalization before it can be applied to systems such as nuclei, atoms, and molecules, which display a tendency towards minimal asymmetry, but in general lack perfect symmetry.

Curie[5] formulated two basic principles bearing on the course of physical processes: (i) when certain causes produce certain effects, any elements of symmetry present in the causes must be preserved in the effects; and (ii) effects may nevertheless be more symmetrical than their causes (as in the vanishing of potential or temperature differences, or of structural distortions). Curie's classic paper needs revision to-day, but it contains valuable suggestions.

Two workers have sought to use Curie's second principle by applying it to phase and higher spaces, and showing that the increase of entropy can be regarded as the decrease of a certain type of formal asymmetry. Sellerio[6] showed that in thermal processes "the structural symmetry (suitably defined) of an isolated system tends to increase"; and Renaud[7] enunciated the "generalized Curie principle" that "if a system changes in such a manner that the causes of its evolution are contained in itself, the number of transformations with respect to which it is invariant can only increase".

But Curie can be followed more closely by applying his principle to fundamental structures in three-dimensional space and so developing a *general theory of one way processes*[8], based on the axiom that *in all isolated processes some three-dimensional structural asymmetry decreases.* (A '*one-way*' process is defined as a finite process which, when isolated, never completes a cycle but continually approaches a characteristic end-state.) The asymmetry may vanish and the end-state possess a symmetry element absent in earlier states, or a minimum residual asymmetry may remain, evidenced as a 'force'. One task is to define the three-dimensional symmetry elements, or residual asymmetries, which determine the equilibrium forms of nuclei, atoms, and molecules of various kinds, and here new methods may be required. This has only been done for the 230 crystal types, where group theory can be applied since there are no (mean) residual asymmetries.

This method implies a basic distinction between spatial and temporal relations, and involves a new approach to the theory of fundamental structures. Yet it appears promising for the following reasons.

(*A*) The limitations of the concept of the 'electrically charged point-particle' and of recent particle theories show the need for a more powerful co-ordinating principle, to be found through a closer analysis of the spatial and temporal relations which underlie, and determine the character of, particular physical measurements.

(*B*) The symmetrical (in logical sense) relations of equality, simultaneity, and spatial symmetry, can be defined in terms of the corresponding asymmetrical relations, while the reverse is not possible, the asymmetrical relations being more comprehensive. This suggests that a unified theory should be based on the asymmetrical relations of one-way processes, and that the theory of the symmetrical relations (conservation principles, reversible laws, etc.) will constitute a special branch dealing with limiting cases where the one-way aspect is negligible. The principle of the conservation of energy may have to be replaced by a more general principle of the conservation of asymmetry (for example, including conservation of spin), valid under certain limiting conditions. In any case, the principle of decreasing asymmetry uses only asymmetrical relations and, being therefore of the highest mathematical generality, is suited to serve as the main axiom of a comprehensive physical theory.

(*C*) Just as the mathematics of 'number' provided the basis of the theory of physical quantities, so the more comprehensive mathematics of 'order' (Russellian relation theory) may provide the basis for the more general theory of one-way processes. One branch of this theory is the thermodynamics of non-equilibrium states (rate of entropy production; Prigogine[9], Tolman and Fine[10], and others).

(*D*) As Curie[5] said, "what is necessary [for the presence of a given field] is that certain elements of symmetry should be absent. It is the asymmetry which creates the phenomenon." The absence of a particular three-dimensional symmetry element (in a given frame) is a *necessary*, but not a *sufficient*, condition for the presence of the corresponding physical field (electric, magnetic, etc.). A second task is therefore the formulation of the necessary and sufficient conditions for the presence of the different physical fields, in terms of purely geometrical relations in three-dimensional space, such as structural asymmetries. (Blackett's equation[11] connecting the magnetic field and angular momentum of massive rotating bodies satisfies one necessary condition for the presence of a magnetic field, the absence of 'axial' symmetry or presence of an axial vector; but it is uncertain whether it expresses sufficient conditions.)

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Oxide Films Formed on Pure Iron in Concentrated Hydrochloric Acid

WORK is being done in this laboratory on various atmospheric corrosion problems. An apparatus has been set up which measures corrosion-rates by following the oxygen consumption. This apparatus will be described elsewhere. During early stages of this work, an investigation was carried out to find a suitable method for cleaning specimens so that repeated use could be made of them. It was found then that treatment of specimens of enamelling iron ($C = 0{\cdot}01$, $Ni = 0{\cdot}1$, $Cr = 0{\cdot}1$, $Si = 0{\cdot}005$, $Mn = 0{\cdot}14$, trace Cu, Sn, As, Al and Ca) in hot dilute hydrochloric acid gave fairly reproducible corrosion-rates using half-normal sodium chloride solutions in the apparatus. Treatment in cold concentrated hydrochloric acid reduced the corrosion-rate of the specimens to a value approximately one and a half times less than the rate after treatment in the dilute acid.

At the end of a test, specimens were originally cleaned with a bristle brush under running tap water, dried and kept in a desiccator. For any one set of specimens the rate of corrosion of the freshly polished specimens was slow but increased during the next two tests, presumably due to the breakdown of oxide film on the polished surface. During the next three or four tests, however, the rate was fairly constant, but decreased after that. If, however, before each test the specimens were cleaned in hot dilute hydrochloric acid (2 *N* at 75° C.) for 15 min., and washed in running tap water for 10 min., the steady rate was reproduced, and could be reproduced continuously. This steady rate will be referred to as the normal rate. Furthermore, freshly ground specimens treated initially in this manner gave the normal rate at once. If instead of dilute hydrochloric acid, cold concentrated hydrochloric acid was used for cleaning the specimens for periods of two or more minutes, with subsequent washing in cold water, the rate of corrosion was much slower than the normal rate. It was even slower than the rate for freshly ground specimens untreated in acid.

Specimens from several sheets of enamelling iron were treated in a similar manner with concentrated hydrochloric acid, and the same effect was noticed with all of them. However, no retardation of the rate occurred with this treatment in the case of two mild steels (0·7° C. and 0·11° C.) or with a spring steel (0·59° C.).

Enamelling iron specimens after cleaning with hot dilute hydrochloric acid were treated in cold hydrochloric acid solutions of varying concentration. The normal rate was observed after treatment in solutions up to a concentration of five normal. With more concentrated solutions the rate decreased suddenly, and in solutions of concentration greater than seven normal the rate again became steady at the lower value.

An investigation carried out to find the reason for this retardation of the corrosion-rate indicated the possible presence of a protective film. For this reason various specimens were examined by electron diffraction in the Industrial Chemistry Division of the Council for Scientific and Industrial Research, Melbourne (by kind permission of Dr. A. L. G. Rees).

The following results were obtained. Treatment in hot dilute hydrochloric acid: surface almost pure iron; slight indication of oxide forming. Surface freshly polished, untouched by acid: iron and films of Fe_2O_3, H_2O and Fe_3O_4 or γ-Fe_2O_3. Concentrated hydrochloric acid treatment: iron and film of Fe_3O_4 or γ-Fe_2O_3. (Patterns for Fe_3O_4 and γ-Fe_2O_3 are indistinguishable, as both have a cubic structure with lattice constant $a = 8{\cdot}4$ A.)

Oxide films have been found on specimens treated in nitric acid and concentrated sulphuric acid, but there seems to be no account of their formation in hydrochloric acid. Several workers have found effects which they have explained as due to other reasons, but in my opinion some of these may well be due to the formation of an oxide film. Thus the results of Guitton[1], Müller[2] and Yamamoto[3] indicate possibilities of oxide film formation.

Müller's theory of passivity may furnish an explanation of the formation of an oxide film. Considering this case to be analogous to the passivity effects noticed in sulphuric acid, the oxide film formation could be due to the anodic process changing its nature at high current densities. Emission of ferric, instead of ferrous, ions, and also deposition of hydroxyl ions with subsequent formation of an oxide film, would occur. The current density due to local cell formation should be greater in more concentrated solutions. Furthermore, the non-appearance of a passive film for the mild steels and spring steel could be accounted for by the stirring produced by the very rapid hydrogen evolution.

An extension of Müller's passivity work to an investigation of the behaviour of iron electrodes in concentrated solutions of hydrochloric acid should help to elucidate this matter.

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Spectra of Iodine and Bromine Solutions

THE assumption of solute-solvent compound formation in certain iodine solutions is largely[1], though not entirely[2], based on spectroscopic evidence, including the violet shift of the visible absorption bond in associated solvents[3], and the appearance of a very strong ultra-violet absorption band at 2970 A. in solutions of iodine in benzene[4]. There are several reasons why the spectroscopic evidence should be interpreted with caution. Solutions of bromine behave spectroscopically in a manner very similar to those of iodine, in that the visible absorption band is displaced to the violet in associated solvents, and in the appearance of a very strong ultra-violet band in the region 2500–2975 A. in several solvents[5]. It has never been stated just why solvation should cause these spectroscopic effects. On the other hand, Bayliss and Rees[6] have shown that the violet shift of the visible absorption band of both iodine and bromine in associated solvents can be explained in terms of the physical effect of the hydrogen-bonded 'cage' of solvent molecules around each solute molecule, and Rees[7] has obtained good quantitative agreement between the calculated and experimental displacements when water is the solvent.

Experimental work now in progress has shown that the ultra-violet band of bromine in benzene has $\varepsilon_{\text{max.}} = 6800$ at 2930 A. and an oscillator strength $f = 0{\cdot}18$ [8], and that the corresponding iodine band has $\varepsilon_{\text{max.}} = 9200$ at 2980 A., with $f = 0{\cdot}23$ [9], the latter result confirming the work of Benesi and Hildebrand[4]. These ultra-violet bands are very strong, and are of the order of magnitude of the (N,V) transitions which occur in gaseous bromine and iodine in the vacuum ultra-violet[10] in the neighbourhood of 1600–1700 A.

On the basis of a simple semi-classical treatment, I have shown recently[11] that, relative to the gas state, an absorption band in solution should be displaced towards the red by an amount (in terms of wave number ν) given by

$$\Delta\nu = (4e^2D/\alpha hc)(1 - 1/n^2), \qquad (1)$$

where α is the polarizability of the solute molecule, n is the refractive index of the solvent in the appropriate spectral region, and D is the dipole strength of the absorption band, which is expressed[10] in terms of experimental data by

$$D = 4{\cdot}0 \times 10^{-20}\, \varepsilon_{\text{max.}}\, \Delta\nu_{1/2}/\nu_{\text{max}}, \qquad (2$$

where $\Delta\nu_{1/2}$ is the 'half-width' of the absorption band. If the strong ultra-violet absorption bands near 2900 A. in iodine or bromine dissolved in benzene are the (N,V) transitions displaced to the red by the physical effect of the solvent, equation (1) accounts for about two-thirds of the observed displacement. The red shift of the visible absorption bands predicted by equation (1) for both bromine and iodine is small (owing to their relative weakness) compared with the observed violet shift, which in this case should be interpreted as the result of the electrostatic red shift superimposed on the violet shift due to the caging effect of the solvent molecules.

It seems clear that, whatever other evidence there may be for solvation in iodine and bromine solutions (for example, the dipole moment data[2]), the spectra can be accounted for almost quantitatively on the basis of the physical properties of the solvents without postulating any special solute-solvent interaction.

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Photoconductivity of Naphthalene and Anthracene

Recent studies[1] of the mobility ('metallic' character) of the unsaturation electrons within molecules containing conjugated double-bond systems suggest that solid conjugated compounds should exhibit the phenomenon of photoconductivity, provided that the unsaturation electrons can acquire enough energy to penetrate the potential barriers between adjoining molecules in the crystal lattice. Photoconductivity has, in fact, been observed in proteins[2] and in certain dyes[3]. We have found that both naphthalene and anthracene, when melted and allowed to solidify between two platinum electrodes about 0·5 mm. apart, show weak photoconductivity when exposed *in vacuo* to the unfiltered radiation from a quartz mercury-vapour lamp. With applied voltages between 50 and 360, the photocurrents are detectable with a good galvanometer. They are of the order of magnitude of 10^{-8} amp., and are superimposed on a rather variable dark current. As in the case of dyes[3], the photocurrents are quenched if air is admitted to the system.

In the case of dyes, the onset and decay of photoconductivity require periods of many minutes[3], a fact which we confirmed in our preliminary experiments. With naphthalene and anthracene, the onset and decay when the shutter is opened and closed are more rapid than the period (3 sec.) of the galvanometer. By using calibrated wire screens to reduce the incident light intensity, we have found the currents to be directly proportional to the intensity.

The photoconductivity of dyes obeys Ohm's law approximately[3]; but with naphthalene and anthracene the relation between current and voltage is exponential. Within the range of voltage employed, good straight lines are obtained by plotting the logarithm of the current (i) against the voltage (v), suggesting the relation $i = a \exp bv$. This relation cannot hold down to $v = 0$, and it suggests comparison with the relation $i = a (\exp bv - 1)$ for contacts between metals and semi-conductors[4]. It is not yet possible to say which potential boundary in the system is responsible for the form of the i–v relationship, namely, the boundary between the metal electrode and the organic compound, the inter-crystal boundaries in the molten compound or the inter-molecular boundaries within a single crystal.

The photocurrents are quenched if a fused silica cell containing distilled water is interposed in the path of the light, suggesting that the active radiation is λ 1849 of the mercury spectrum.

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Effects of Very Fine Solid Particles on Flame Propagation

Methods of promoting gaseous combustion reactions are usually of both practical and theoretical significance. Some preliminary observations made by us recently on the apparent influence of very fine solid particles on flame propagation may therefore be of interest.

The particles were introduced into the fuel–air mixture by passing the air (or in some cases its nitrogen constituent), before mixing, through an arc struck between metal electrodes. The mixture was then passed into a long 2-in. diameter vertical glass tube for measurements of limits of inflammability according to the 'flow' method used by Burgoyne and Williams-Leir[1]. The temperature of the gas mixture at the point of application of the igniting source was only a few degrees above atmospheric.

In some cases quite a marked widening of the inflammable range was observed when the arc was in operation. Thus, with iron electrodes and all the air passing through the arc, the lower limit (upward propagation) for hydrogen in air was reduced from 4·0 to 3·5 per cent and that of ethylene from 3·4 to 2·7 per cent. Under the conditions of operation the concentration of iron in the ethylene–air limit mixture was approximately 10^{-3} per cent by weight. Electron diffraction patterns indicated that the particles were iron oxide and of the order of 300–500 A. in diameter. Experiments have also been made with methane and with various electrode materials, including carbon. In most, though not in all cases, lower limits are lowered and upper limits raised.

In collaboration with Dr. A. G. Gaydon we have made spectroscopic observations on stationary ethylene–air flames containing particles similarly introduced. The most interesting result is that, with iron electrodes in use, certain Fe lines of high excitation at about 3000 A. occur only in the inner cone of the flame. When copper electrodes are employed, well-marked CN bands are obtained. At present we are studying the chemical effects of the particles on the reactions underlying flame, and consideration is also being given to the physical factors influencing the effects on flame propagation. It would be premature, however, to offer any definite conclusions yet regarding this part of our work.

After we had carried out the preliminary work on limits of inflammability, we realized that some experiments of Lewis and Kreutz[2] on the subject of 'ionization' are probably relevant to our observations. They found a considerable lowering of the ignition temperature of methane–air mixtures the incombustible constituents of which had traversed nickel electrodes across which high-tension sparks were passing. We think it likely that this effect and the effects that we have observed have a common cause.

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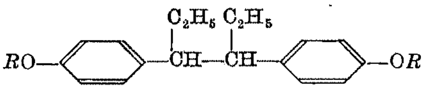
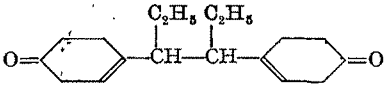
Reduction by Sodium – Ammonia Solutions

REDUCTION of methoxybenzene derivatives by the sodium–ammonia–alcohol reagent followed by acid hydrolysis leads to the formation of a number of hitherto inaccessible unsaturated ketones[1]. The process fails with some compounds because of their insolubility in liquid ammonia, a typical example being hexœstrol dimethyl ether (I, $R = CH_3$). This substance has been treated under a variety of conditions and with admixed solvents, for example, ether or ethylenediamine, but so far without success.



I



II

The observation that alcohols are often readily soluble in ammonia has now led us to replace the methyl ethers of phenols by the 2-hydroxyethyl- or glyceryl-ethers. These ethers are, in fact, more readily soluble in ammonia and are easily prepared by the action of the appropriate chloro-compound on the sodium phenoxide in hot aqueous solution. The ether side-chain is lost during acid hydrolysis, so its nature does not affect the final product. A further advantage with these ethers is that any unreduced material present in the product can be removed because of its relatively higher boiling-point.

Hexœstrol (I, R=H) gives rise to a *bis*(2-hydroxyethyl) ether (I, $R = -CH_2CH_2OH$) which crystallizes as colourless plates from benzene, m.p. 90–91° (found: C, 73·4; H, 7·9; $C_{22}H_{30}O_4$ requires C, 73·7; H, 8·4 per cent). This is readily reduced and gives after acid hydrolysis 3:4-di(4′-ketocyclohex-1′-enyl)hexane (II), which forms clusters of prisms from ether–light petroleum, m.p. 131–132° (shrinks 120°) (found: C, 78·6; H, 9·9; $C_{18}H_{26}O_2$ requires C, 78·5; H, 9·5 per cent) (bis-semicarbazone m.p. 242° (decomp.)). The formulation of (II) as the βγ-unsaturated ketone rests on the lack of an absorption maximum in the region 2200–2700 A. It is being tested for possible sex-hormone activity.

The reduction of other phenols, including œstrone, and the synthesis of some natural products are being carried out.

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[1] Birch, *J. Chem. Soc.*, 593 (1946).

Re-arrangement of Acyldiazoethanes

THE appearance of a paper by Wilds and Meade[1] on this topic renders an account of our own experiments desirable, more especially as we have in various respects carried the matter further than the American workers.

The statement (without experimental details) by Eistert[2] that *p*-nitrobenzoyldiazoethane is convertible in hot aniline to α-(4-nitrophenyl)propionanilide has been experimentally confirmed, most satisfactorily by addition of the diazo-compound to the base at 100–105°. Similarly, anilides of *iso*butyric, α-phenyl and α-(4-methoxyphenyl)-propionic acids, and the dianilide of αα′-dimethylsuberic acid were prepared.

While these results are doubtless to be attributed to initial thermal decomposition of the diazo-compound to a ketene[3], followed by reaction with aniline, it is incorrect to assume[4] that this is also the mechanism of the Wolff re-arrangement as usually performed. This has been recognized by Eistert[5]; but we are also unable to accept his views in regard to the latter reaction; for successive additions to an ethanolic solution of benzoyl (or 4-methoxybenzoyl)-diazoethane (1 mol.) at 70° of an ethanolic solution of aniline (1 mol.) and of 10 per cent aqueous silver nitrate solution yielded β-anilinopropiophenone (or its 4-methoxy-derivative):

$$PhCOCMe = N = N \rightarrow PhCOCH_2CH_2NHPh + N_2.$$

This clearly arises from addition of aniline to benzoylethylene (I), the formation of which recalls that of olefines together with primary and secondary alcohols by decomposition of the diazonium compounds resulting from the action of nitrous acid on primary aliphatic amines[7]. We thus conclude that the course of the reaction is to be expressed as follows, the base functioning alternately as acceptor and donor of proton:

$$\begin{array}{l} PhCO.CMe{=}N{=}N \rightarrow [PhCO.CHMe.N{\equiv}N]^{\cdot} + PhNH_2 \\ \quad + PhNH_3^{\cdot}\ , \qquad\qquad \downarrow \qquad\qquad (Ag) \\ \qquad\qquad\qquad PhCO.CH{=}CH_2 + PhNH_3^{\cdot} + N_2 \\ \qquad\qquad\qquad\qquad\quad (I) \end{array}$$

Similarly, the normal Wolff re-arrangement corresponds to the Wagner–Meerwein re-arrangement by which the formation of secondary alcohols occurs. Thus, in the case of benzoyldiazomethane and ammonia, we have

$$\begin{array}{l} PhCOCH{=}N{=}N + NH_4^{\cdot} \quad \rightarrow \quad [PhCO.CH_2.N{\equiv}N]^{\cdot} \\ \qquad\qquad\qquad\qquad\qquad\qquad + NH_3 \\ \qquad\qquad\qquad\qquad\quad (A) \downarrow \quad NH_3 \\ \qquad\qquad\qquad NH_2CO.CH_2.Ph + NH_4^{\cdot} + N_2. \end{array}$$

Evidently, also, when the opportunity is available for both types of charge, the former occurs in preference to the latter.

The preparation, for the reactions just discussed, of acyldiazoalkanes from acid chloride and diazoalkane requires an excess of the latter to react with the hydrogen chloride formed[8]. Whereas, however, in the use of diazomethane any adequate excess may be employed, either this, in the case of diazoethane and, it may be presumed, its homologues, should be limited to that theoretically requisite, or, if excess be employed, the duration of the reaction should be limited; for *p*-nitrobenzoyldiazoethane, m.p. 112°, reacts with diazoethane at the ordinary temperature in ethereal solution to yield a product

$$\begin{array}{l} NO_2 . C_6H_4 . CO . CMe = N = N + MeCH = N = N \\ \rightarrow NO_2 . C_6H_4 . CO . C(Me) = N - N = CHMe \quad (II) \end{array}$$

characterized as the ketazine (II) by conversion into acetaldehyde, hydrazine and acetyl-*p*-nitrobenzoyl on hydrolysis with hot dilute sulphuric acid. This product is naturally also formed in the preparation of *p*-nitrobenzoyldiazoethane unless the precautions just outlined are observed. Similarly, nitrobenzoyldiazomethane and diazoethane furnish the azine $NO_2.C_6H_4COCH=N-N=CHMe$ (III), but the anionoid reactivity of diazomethane is inadequate to enable it to participate in this type of reaction with the cationoid nitrogen atom[8] of acyldiazoalkanes. While, however, the reactivity of this latter is doubtless enhanced by the acyl group, the formation of azine in this manner is by no means unique. The conversion of diazo-*iso*propane into $Me_2C=N-N=CMe_2$ at the ordinary temperature[9] and the numerous other examples of ketazine formation cited by Staudinger and Kupfer[10] are clearly to be regarded from this aspect, which has hitherto usually been neglected owing to the almost exclusive attention accorded to the anionoid reactivity of aliphatic diazo-compounds. But the conversion by alkali of diazoacetamide into a triazolone[11] is an example of the cationoid reactivity in question, while that of diazoacetic ester into a dihydrotetrazine dicarboxylic acid[12], as well as the classical synthesis of pyrazolines[13], also involves cationoid as well as anionoid reactivity of diazo-compounds.

The ketazine (III) does not represent the limit of the reaction between *p*-nitrobenzoyldiazomethane and diazoethane, for if excess of the latter be employed, a compound $C_{14}H_{17}O_3N_3$ (IV), m.p. 134–135°, is formed, with evolution of a corresponding volume of nitrogen. The nature of this product is not completely established; but on treatment with dilute sulphuric acid it readily yielded acetaldehyde, together with a compound, m.p. 196–197° (also obtainable by gradual addition of hydrochloric acid (2*N*) to a solution of (IV) in dioxan at the ordinary temperature), and another, m.p. 175–176° (also obtainable by gradual addition of ethanolic hydrazine hydrate to an ethanolic suspension of III at the ordinary temperature). In view of these results, ketazine (II) would also be expected to react with diazoethane, and, in fact, does so, though much more slowly than (III). It also undergoes gradual internal condensation to a compound $C_{11}H_9O_2N_3$, m.p. 158–159°, in boiling ethanolic solution.

Benzoyl- and 4-methoxybenzoyldiazoethanes react much more slowly than the 4-nitro-analogue with diazoethane; but evidence of ketazine formation in these cases also has been derived from hydrolytic experiments.

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[2] *Angewandte Chemie*, **54**, 124 (1941).

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[9] Staudinger and Gaule, *Ber.*, **49**, 1897 (1916).

[10] Staudinger and Kupfer, *Ber.*, **44**, 2197 (1911).

[11] Curtius *et al.*, *Ber.*, **39**, 4140 (1906); **43**, 2446 (1910).

[12] *Ber.*, **41**, 3161 (1908); **42**, 3284 (1909).

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Organised Structure in Soap Solutions

My simple picture, fully described elsewhere[1–3], of the aggregates in the clear mobile solutions of paraffin-chain salts is that they are essentially liquid in nature and spherical in form. The discovery[4], by X-ray diffraction, of a characteristic long spacing, decreasing with increase of concentration, appeared to favour a different picture—that of a lamellar micelle in which the chains lay parallel to one another and the outer faces of arrayed ionic groups were separated by a definite thickness of water. One of the protagonists of the lamellar micelle has recently[5] come to modify his picture considerably, and his collaborator[6] to consider that the X-ray data can be explained by the spherical micelle.

There are two difficulties about the lamellar micelle explanation of the X-ray spacings. One, recently raised by Bernal[7], is that in order to account for all the water, the lamellæ must be assumed to be separated laterally by a greater depth of water than that held between the ionic faces. The opposite difficulty was raised by Harkins[8]. When oil is dissolved in the soap micelles, the increase of long spacing is much *greater* than is directly accounted for by the additional volume inside the micelle.

The characteristic long spacing should be considered as a regular distance between geometrically similar groups of diffracting atoms. These need not be planes. They may be spheres regularly spaced, as in the transparent emulsion studied by Schulman and Riley[9].

There are good reasons[3] for believing the micelles to be of closely constant size in any one solution and to vary but little with the concentration. The constancy of spacing demonstrated in concentrated solutions is simply the result of a coulombic packing effect. The micelles are highly mutually repulsive and will therefore tend to array themselves so that their shortest distances of separation are as great as possible, that is, in a closely packed tetrahedron assembly. If the spheres are of radius r and together occupy a fraction φ of the total volume, then their shortest distance d of separation in this arrangement will be given by

$$d = \left(\frac{8\pi}{3\sqrt{2}}\right)^{1/3} . \varphi^{-1/3} . r.$$

We will apply this equation to the data of Harkins for potassium laurate and of Stauff[10] for sodium tetradecyl sulphate. To a sufficient degree of accuracy, we can take the mean density of the micelles equal to 1, and thus identify weight and volume fractions. We will calculate r from observed values of d.

Potassium laurate			Sodium tetradecyl sulphate		
Wt. %	d (obs.)	r (calc.)	Wt. %	d (obs.)	r (calc.)
9·1	57·0 A.	14·2 A.	15·1	60–65 A.	17·7–19·1 A.
12·1	56·3	15·4	40·0	55·0	22·3
16·7	51·3	15·6	60·0	48·2	22·5
25·0	47·1	16·4	80·0	42·4	21·7
33·3	44·1	17·0			
41·1	37·1	15·2			

The lengths of the fully extended chains are about 13·7 and 18·9 A. The calculated values are consistent with the sphere radius being, as expected, a little greater than this length[3].

What of the effect of dissolved oil? In a limited region in the centre of the micelle, the oil will probably be the sole component[11]. The radius of the micelle will thus be disproportionately increased, and a disproportionate increase of d will result directly from that of r.

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Paper Partition Chromatography of Riboflavine Decomposition Products

THE photolysis of riboflavine has always been considered[1] to be a complex process, but as a rule only the final products, lumichrome (6 : 7 dimethyl alloxazine) and lumiflavine (6 : 7 : 9 trimethyl *iso*alloxazine), have been isolated.

Using Crammer's[2] method and subjecting irradiated samples of riboflavine solution to chromatography, we were able to demonstrate several distinct spots with a very bright fluorescence in ultra-violet light. For the runs, either Whatman No. 1 or Schleicher–Schüll No. 237 filter paper and either the descending or ascending arrangement[3] was used with practically the same results. The ascending arrangement showed more irregularities of flow. 0·08–2·5 μgm. of riboflavine gave satisfactory spots, smaller samples giving too faint a spot and larger ones causing some tailing between the start and position R_F 0·35. Fluorescence was observed in filtered ultra-violet light (Phillora WPH—125 W.). The fluorescence was strong enough to allow the assessment of the fluorescence emission maxima of some spots when irradiating the chromatograms by ultra-violet light and observing the spectrum by means of a Hilger prism ; there was some difficulty due to the weak white fluorescence of the paper background. Good separation was observed using the upper layers of mixtures of butanol, acetic acid, and water (4 : 1 : 5) or butanol, pyridine and water (3 : 4 : 7) as the mobile phase.

Riboflavine was identified by comparing with a carefully prepared fresh solution of riboflavine in sodium salicylate (our R_F was higher than that reported by Crammer[2], who found 0·3 in butanol–acetic acid–water). Lumichrome was compared with a sample prepared according to Karrer *et al.*[4]. Its spot interferes with that of the salicylate in butanol–pyridine–water. Several weaker unidentified spots with R_F less than that of riboflavine in butanol–acetic acid–water were observed, the most constant of them (B) having R_F 0·3. The possibility that some of the spots are due to more than one substance cannot be excluded until a check by two-dimensional chromatograms is made.

The stability of the substances during chromatography in darkness was tested using the two-dimensional principle, but developing with the same solvent pair (butanol–acetic acid) for the first as well as for the second run. The spots then occupied the diagonal position. As would be expected[5], sodium hydroxide solution changes the fluorescence of lumichrome spot to yellow and extinguishes those of the other photolytic products.

After exposure to hydrogen peroxide in alkaline solution, the spots of riboflavine and lumichrome were accompanied by three more spots, two with blue and one with orange fluorescence, although riboflavine has generally been reported to be stable to oxidizing agents[1]. Heating in alkali resulted in the disappearance of the other spots and the appearance of a new one with a bright ultramarine fluorescence and R_F 0·51 in butanol–acetic acid. The results are summarized in the accompanying table.

Spot due to		R_F in BuAc	R_F in BuPy	Colour	Fluorescence in u.-v. light
after illumination	(A) not identified (adsorbate on paper ?)	0·0	0·0	yellow	yellow
	(B) not identified	0·30			yellow
	(C) riboflavine	0·37	0·57	yellow	yellow
	(D) lumiflavine ?	0·49	0·54	yellow	yellow
	(E) lumichrome	0·70	0·76	φ	greenish-blue (max. 490 mμ)
Salicylate (when used as hydrotropic agent)		0·92	0·76	φ or pink	blue
Action of hydrogen peroxide on alkaline solution of riboflavine		0·08 0·22	0·23 0·52		blue
		0·16	0·37		orange

Commercial injection solutions were analysed by this method, which seems suitable for following the influence of various conditions on the rate and nature of photolysis. The nature and conditions of formation of the unidentified substance B are under investigation.

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Dec. 24.

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A Source of Error in the Colorimetric Estimation of Uranium

FOR several years I have obtained consistent results with the hydrogen peroxide method[1] for the estimation of uranium, the intensity of the peruranate colour being measured with a Pulfrich photometer with filter S.43 (effective filter gravity, 434 mμ). In the hope of achieving greater accuracy and reproducibility, a modern type of spectrophotometer was recently substituted for the visual photometer; the colours being measured at 360 mμ (where the extinction for a given uranium content is nearly three times greater than at 434 mμ). It was found, however, that results were frequently low by as much as 30 per cent, although the same solutions gave the correct result when the absorption was measured with the Pulfrich photometer.

The source of error was eventually traced to the presence of sodium bicarbonate, which is formed in varying amounts when the acid solutions from ether extractions are treated with an excess of sodium carbonate, prior to the addition of hydrogen peroxide. A study of transmission curves showed that addition of bicarbonate caused a considerable decrease in the absorption of solutions in the near ultra-violet (350–400 mμ); but the effect became less marked at longer wave-lengths and disappeared entirely in the region 440–450 mμ. The reason for consistency of results with the Pulfrich photometer thus becomes apparent, and no error will occur using a spectrophotometer if readings are made at 440–450 mμ; but certain precautions must be taken if it is desired to take advantage of the greater sensitivity obtained when measurements are made at lower wave-lengths.

Since the magnitude of the error varies with the amount of bicarbonate as well as with the concentration of sodium carbonate, a correction is difficult to apply, and it is necessary instead to ensure that no appreciable quantities of bicarbonate are present. This cannot be conveniently done by boiling the solutions, since the presence of excess sodium carbonate causes a marked decrease in the rate of decomposition of bicarbonate, and appreciable quantities of the latter may persist in solution after boiling for more than an hour. The most reliable technique is to avoid the formation of bicarbonate altogether by neutralizing the acid solutions containing uranium with sodium hydroxide; the neutral solutions are then treated with sodium carbonate and the colour developed as usual with hydrogen peroxide.

Further details of experiments and discussion of results will be published elsewhere.

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Insecticidal Power and Microscopical Structure of Residual Films of Phenyl-*iso*nitrile and Benzene Hexachloride

In the fight against pistachio nutworm (*Eurytoma pistaciæ*, Anagnos) and pistachio tree leafhopper (*Idiocerus pistaciæ*), we made use of a new insecticide, the basis of which is phenyl-*iso*nitrile. At first it was mixed with nicotine and lead arsenate; later, instead of nicotine and lead arsenate, we added benzene hexachloride. This preparation proved to be promising, owing to the fact that the one constituent—phenyl-*iso*nitrile—kills the insects and at the same time repels them, while the other constituent—benzene hexachloride—not only kills them but also causes the preparation to remain active for a much longer period. This preparation is used in the form of a water-suspension which is sprinkled on the trees diluted with water.

A. J. Musgrave[1] found that residual films of a sample of technical grade benzene hexachloride prepared on glass plates from chloroform solutions showed a stronger insecticidal power than other samples of different manufacture. A microscopical examination carried out by him showed that the film was present in the form of discrete globules. He suggests that high toxicity may be associated with traces of chloroform retained by the film.

We prepared several residual films, on glass plates, of benzene hexachloride as well as of mixtures of benzene hexachloride and phenyl-*iso*nitrile, and we tested them on a species of Myrmicine ant which shows almost the same resistance to insecticides as does *Eurytoma pistaciæ*.

We find that the toxicity does not depend on the organic solvent—chloroform, benzene, alcohol, kerosene oil—from which the film is prepared, but it is in direct proportion to the capacity of the insecticide to adhere on the insect. Comparative tests carried out on glass plates dusted with these insecticides in the form of dry dust containing inert matter showed that the death of the insect occurs more quickly—in about half the time—than when the films were prepared from solutions of the insecticides in organic solvents, in which case the film is better retained on the plate. The quantity of the insecticide used in both cases was the same.

Furthermore, films prepared from solutions of the insecticides killed the insects more quickly when some traces of the organic solvent could be retained in any way by the film. It is justifiable to say that this is due to the greater adhesion of this form of film to the insects. Pure vapours of organic solvents do not seem to cause death of the insects but only a transitory unconsciousness.

A similar effect happens in the case observed by Musgrave. The insect *Dermestes maculatus* Deg., walking on the film, which was present in the form of discrete globules containing traces of chloroform, caused crystallization of the benzene hexachloride, but at the same time owing to the presence of traces of the solvent the insecticide adhered better to the insect. Another fact which must be taken into consideration is that the vapour pressure of the insecticide in the form of discrete globules is greater than that in any other form, as then the insecticide is in the condition of a supersaturated solution; it is known that benzene hexachloride acts as a fumigant as well as a stomach and contact poison.

In general, benzene hexachloride as well as mixtures of benzene hexachloride and phenyl-*iso*nitrile form residual films of greater toxicity when the films are prepared from solutions with organic solvents, instead of water-suspensions of a wettable form of the insecticides (the insecticide contains inert matter with a wetting agent). Unfortunately, most organic solvents 'burn' the plants. The mixture of benzene hexachloride and phenyl-*iso*nitrile had a higher toxicity than either benzene hexachloride or phenyl-*iso*nitrile alone.

The experiments are being continued.

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Dem. Augustides

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A Saprophytic Liverwort

The saprophytic liverwort described in this communication was found by Mr. M. V. Brian, of the Department of Zoology in this University, early in December 1948, while investigating an ant's nest in a wood near Cardross, Dumbartonshire. The first specimens found and brought into the Botany Department were white, fleshy, irregularly lobed bodies which were provisionally identified as the thalli of a liverwort. A little later, Mr. Brian found further material, which, since it bore young sporogonia, could be identified as a species of *Aneura*, or, at any rate, as being closely related to that genus.

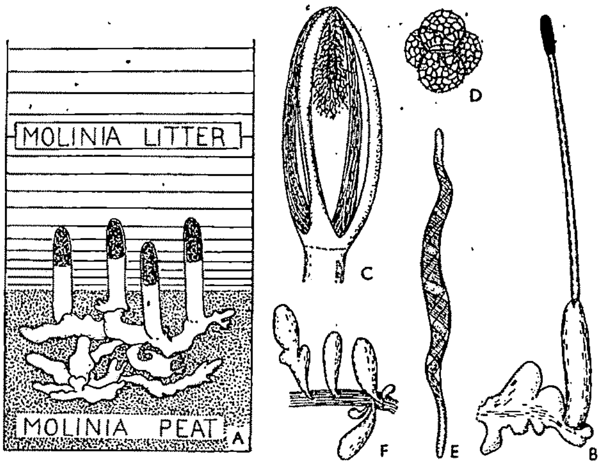

Fig. 1. *A*, Diagram showing plants *in situ*, with young sporogonia (× 0·8); *B*, thallus, collected in the field in February, bearing a ripe sporogonium (× 1); *C*, dehisced capsule (× 7); *D*, spore tetrad (× 220); *E*, elater (× 220); *F*, young plants growing on a decayed fragment of *Molinia* leaf (× 1·2)

Since then, Dr. Bond and I have examined the plant in the field, and a fuller investigation has been started since its completely saprophytic habit is of considerable interest. The occurrence of a similar saprophytic liverwort in France was reported in 1919 by Denis[1]; but, apart from this brief account, referred to by Rayner[2] and by Nicolas[3], I know of no further reference in the literature.

So far, the plant has only been found in a very restricted area on the site of a felled wood, now colonized by young birch. In this particular area the ground vegetation is dominated by *Molinia cœrulea*. The liverwort, fairly abundant in this small area, is found embedded at varying depths ($\frac{1}{4}$–3 in.) in the black, nearly amorphous peat formed between the tussocks of *Molinia*. The *p*H of this peat has been determined by Dr. Bond as being 3·9. At this time of the year, the *Molinia* peat is overlain by a considerable depth of litter in various stages of decay, formed mainly by the deciduous *Molinia* leaves, but including also birch leaves, shoots of *Polytrichum*, and other constituents of the flora.

The position of the liverwort in relation to the peat and overlying litter is shown in Fig. 1,*A*. The thallus is white, fleshy in texture, and much branched and lobed, giving an almost coralloid appearance. Sectioning reveals the presence of coils of septate fungal hyphæ in the lower cells of the thallus, and hyphæ are also present in many of the rhizoids (Fig. 2,*D*). Many of the cells present an appearance similar to that shown by the 'digesting cells' of the root of *Neottia*, the fungus being in a 'clumped' condition. Above the fungal zone the cells of the thallus contain abundant compound starch grains. It may be noted here that Rayner (*loc. cit.*) figured a *Rhizoctonia* type of fungus in the thallus of *Aneura pinguis*.

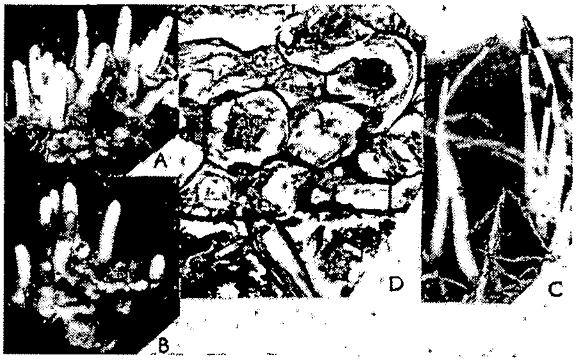

Fig. 2. *A*, Block of *Molinia* peat dissected at its edge to show embedded thalli bearing young sporogonia (× 1); *B*, thallus with young sporogonia showing through the translucent calyptra (× 1); *C*, ripe sporogonia, with one on the left showing the method of dehiscence, borne on plants grown in an incubator and not covered by litter (× 1); *D*, tangential longitudinal section showing hyphæ in thallus cells and a rhizoid (× 150)

The sporogonia appear to be similar in origin and structure to those of the genus *Aneura* and need not be fully described here. Fig. 1,*B–E*, will sufficiently indicate the characters of the capsules, spores and elaters. Fungal hyphæ have not been detected in any part of the sporogonium. The distribution of the sexual branches has not yet been fully determined.

The dehiscence mechanism of the capsule differs from that described for the genus *Aneura*. The capsule wall (similar in construction to that of *Aneura pinguis*) splits into four valves which, however, remain coherent at their tips. The distal elaterophore remains as an undivided, club-shaped mass of tissue hanging down into the capsule. As the longitudinal slits appear and widen, the mass of spores and elaters within enlarges and emerges as a reddish-brown mass. The spores are slowly dispersed and the capsule is finally emptied, leaving it in the condition shown in Fig. 1,*C* and Fig. 2,*C*. Dehiscence has not been observed in the field; but it must frequently, if not always, take place in a confined space in the overlying litter, and it is possible to think of the method of dehiscence as being related to this fact. Mention may be made, however, of the fact that comparable modes of dehiscence have been described in *Pallavicinia* and *Moerckia*.

Young plants (from 1 mm. in length upwards) have also been found (Fig. 1,*F*). They occur in clusters on decaying roots and *Molinia* leaf fragments at varying depths in the litter and peat, the clustered condition probably being the result of a restricted spore dispersal imposed by the position of the capsule. Even the smallest of the plants shows copious fungal infection of the rhizoids and tissues. Like the adult, the young plants are devoid of chlorophyll.

The plant is being more fully investigated, both anatomically and experimentally, since it obviously may yield facts of interest in relation to the general problems raised by the mycorrhizal condition both in liverworts and in other plants. The systematic position of the liverwort and the question of nomenclature will also have to be considered.

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Photoperiodic Control of Leaf Growth and Cambial Activity in *Pinus sylvestris*

It has long been known[1] that geographical races of *Pinus sylvestris* from northern latitudes show reduced growth of the shoot when planted in more southern localities. Sylven[2] and Langlet[3] suggested that this is probably a photoperiodic effect, arising from differences in the natural length of day between different localities. My experiments have shown that *Pinus sylvestris* is indeed photoperiodic. As in many other species[4], short photoperiods (10 hr.) induce earlier cessation of growth of the shoot in first-year seedlings of *P. sylvestris* as compared with long photoperiods (15 hr.), so that fewer leaves are formed before the formation of a terminal resting-bud. There is also a reduction in the length of the 'internodes', leading to a rosette type of growth, under short days.

After the first year, however, growth of the annual shoot consists solely of expansion of the initials already laid down in the terminal bud[5], and hence in older plants day-length can have no direct effect on the duration of growth of the shoot or on the number of leaves formed. There is, however, as in first-year seedlings, a reduction in the extension of the stem under short days, leading to a shorter distance between successive dwarf shoots.

The leaves of *Pinus sylvestris* are organs of 'indeterminate' growth, and activity of the meristem at the base of the needles results in their continuous growth in length until late August under natural day-length conditions; under a 10-hr. photoperiod, however, they cease growth six to eight weeks sooner, so that their final length is much reduced. It seems probable that cessation of needle-growth in the autumn is controlled by the reduced day-length conditions then prevailing.

Day-length is also found to affect the duration of cambial activity. Two series of two-year-old seedlings of *P. sylvestris* were kept under (*a*) natural and (*b*) 15-hr. photoperiods respectively from the end of August (when leaf-growth had ceased), the longer photoperiod being obtained by giving supplementary low-intensity (20–25 foot-candles) illumination to extend the natural photoperiod. Wight[5] has pointed out that in *P. sylvestris* a dormant cambium can be distinguished from an active one by the fact that in the former there is a sharp boundary between the cambial cells and fully lignified xylem elements, whereas in the presence of an active cambium there is a zone of partially lignified tracheides between the cambium and the fully differentiated elements. Using this criterion, an examination of the two series of plants at the end of October showed that under the natural day-length conditions the cambium was dormant or showed only slight activity, whereas in the majority of the plants under the 15-hr. day the cambium was still very active. Confirmation of these results was obtained in other experiments in which constant photoperiods of 10 hr. and 15 hr. respectively were used.

In poor specimens the cambium was dormant irrespective of the day-length treatment, and hence it would appear that nutritional conditions also affect the duration of cambial activity. Provided these other conditions are not limiting, however, cessation of cambial activity in *P. sylvestris* is evidently controlled by the reduced natural day-length in the autumn, and is probably only one indication of the incidence of a general state of dormancy, which in deciduous species includes photoperiodic induction of leaf abscission[6]. The inhibition of cambial activity by short days is effective only at the end of the growing season, for two-year plants grown under a 10-hr. photoperiod in the spring showed definite (though reduced) secondary growth, at least until the cessation of leaf growth.

Cambial activity, leaf abscission and extension of the stem are processes well known to be controlled[7,8] also by auxin supply, auxin deficiency having the same effect as short photoperiods. It seems possible, therefore, that these photoperiodic effects in woody species result from the action of light on the production or availability of auxin within the plant, and that quite low light intensities are effective.

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Nov. 12.

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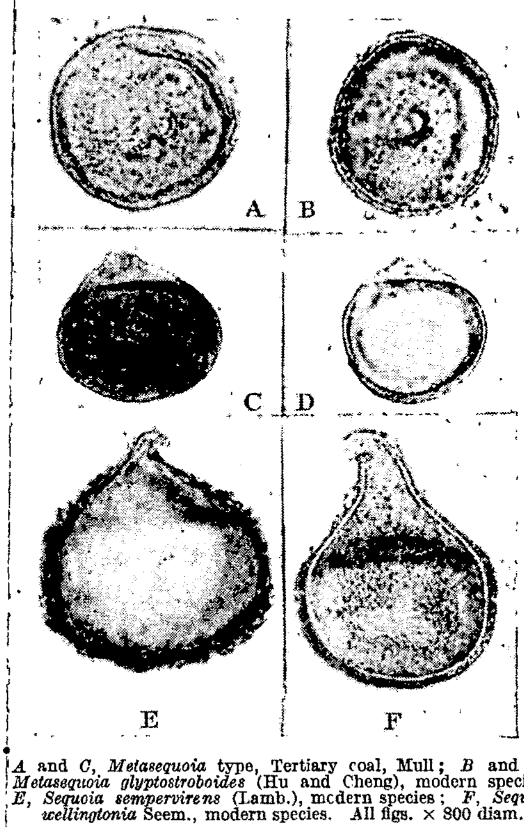
Fossil Pollen of *Metasequoia* Type

Recently, by the kindness of Mr. Orr, of the Royal Botanic Gardens, Edinburgh, I was able to make preparations of the pollen of *Metasequoia glyptostroboides*, the 'living-fossil' discovered in China a few years ago. On examining this pollen, I was at once reminded of certain fossil grains observed in Tertiary coal from Mull, Scotland, which I had been unable to match to my complete satisfaction with the grains of any living conifer. They showed characters most suggestive of *Glyptostrobus* and *Taxodium* and, less closely, of *Sequoia*.

The striking resemblance of these fossil grains to *Metasequoia* pollen, however, will now be evident from the accompanying photograph. *A* and *B* are corresponding polar views of fossil and living grains; *C* and *D* are, likewise, meridional views. In the meridional view the coniform process with its curved tip (an air sac at the distal pole of the grain) is



A and *C*, *Metasequoia* type, Tertiary coal, Mull; *B* and *D*, *Metasequoia glyptostroboides* (Hu and Cheng), modern species; *E*, *Sequoia sempervirens* (Lamb.), modern species; *F*, *Sequoia wellingtonia* Seem., modern species. All figs. × 800 diam.

practically identical in shape, while in the polar view the optical section through the curved tip is also very similar. It will be noted that these grains are quite distinct from the pollen of *Sequoia sempervirens* and *Sequoia wellingtonia*, which are shown for comparison (*E*, *F*).

Despite a prolonged search in the Mull coal, I have not seen pollen resembling that of the living species of *Sequoia*. It would, indeed, be interesting if other lines of palæobotanical research on *Sequoia*-like material of British origin, for example, examination of leaf cuticle, seed and wood anatomy, also suggest relationship to *Metasequoia*.

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Brillouin Zone Effects in Aluminium Alloys

IN experiments on the solid solutions of zinc in aluminium, it has been found that there are marked deviations from Vegard's law in alloys containing less than 25 atomic per cent zinc. The deviations of the lattice spacing/composition curve from a straight line are a maximum at 16·5 atomic per cent zinc, coincident with the formation of the α'-phase at 275° C. Further, when the α'-phase is formed, the lattice spacing of the α-phase remains constant over the composition range 16·5–25 atomic per cent zinc and the corresponding temperature change from 275° to 315° C.

These results have led to a more detailed examination of the solid solutions of zinc in aluminium, and it has been found by density measurements at 283° and 318° C. that a defect lattice of the type reported by Bradley and Taylor[1] is formed, there being 5·6 per cent vacant lattice sites at 16·5 atomic per cent zinc (assuming that the pure aluminium which was used as a standard in the density measurements contained no vacant lattice sites) and less than 0·5 per cent vacant sites at 25 atomic per cent zinc. It would appear that the slope of the lattice spacing/composition curve can be correlated with the formation of vacant lattice sites in the solid solution, and that in the composition range 16·5–25 atomic per cent zinc, where the α'-phase is in equilibrium with the α-phase, the lattice spacing remains constant while the vacant sites fill up.

By the formation of vacant lattice sites the electron concentration per unit cell is reduced, and it would appear probable that the electron concentration at the point where the number of vacant lattice sites is a maximum corresponds with the filling of a Brillouin zone. In this case it is of the order of 2·68 electrons per atom, taking into account the effect of the vacant lattice sites.

It has been pointed out by Fink and Freche[2] that the plot of log S against $1/T$ gives a straight line for a number of aluminium-rich solid solutions, where S is the atomic percentage of the solute in solution at the limit of the solid solution at T° Abs. It is found that the solution of zinc in aluminium does not obey this law, and this is further evidence that this solid solution is abnormal.

The aluminium–magnesium and aluminium–silver systems also have fairly wide aluminium-rich solid solutions. Neither solution obeys the law of Fink and Freche, and by analogy with the aluminium–zinc system, this may also be due to the formation of vacant sites.

It is suggested that an electron atom ratio of about 2·68 corresponds with the filling of a zone in these alloys. Such a suggestion, however, is not in accord with the $N(E)$ curve for aluminium recently calculated by Matyas[3].

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Application of Similarity to Anelasticity

KE[1] has shown that, when the internal friction and relaxation of rigidity for very pure aluminium are measured as functions of grain size (D), temperature (T) and frequency of vibration (ω), the effects of these three variables can be stated in terms of a single parameter:

$$D.\omega.\exp H/RT, \tag{1}$$

where H is an activation energy of 32,000 cal./mol. The exponential term represents[2] the temperature variation of the coefficient of intergranular viscosity. This parameter has the disadvantage that it is not dimensionless, so that it is not possible to transfer the results of Ke's experiments to other metals. It is therefore of interest to apply dimensional analysis to this system in the attempt to derive a dimensionless criterion for the ratio of the relaxation time $\bar{\tau}$ to the vibration time $1/\omega$. Lord Rayleigh[3] has pointed out that fundamental laws can frequently be derived by such dimensional analysis.

One way of doing this is to start from the fundamental equation for a standard linear solid given by Zener[4] in the form

$$\tau + t_\gamma\dot{\tau} = G_R(\gamma + t_\tau\dot{\gamma}), \tag{2}$$

where τ is the shear stress, γ is the strain, G_R is the relaxed rigidity modulus, t_γ, t_τ are the relaxation times for stress and strain respectively under constant strain and stress. The geometric mean relaxation time $\bar{t} = \sqrt{t_\gamma t_\tau}$ represents the measure of the time-scale of the system governed by equation (2). To apply similarity theory it is, however, necessary to introduce a viscosity[5]

$$n = \bar{t}\,.\,\bar{G} = t_\gamma\,.\,G_u = t_\tau\,.\,G_R, \tag{3}$$

where $\bar{G}$ is the geometric mean of the relaxed (G_R) and unrelaxed (G_u) rigidity moduli. Equation (2) then takes the form

$$\tau + (\eta/G_u)\dot{\tau} = G_R\gamma + \eta\dot{\gamma}, \tag{4}$$

and the dimensionless parameter for the transition from the relaxed (ω small) to the unrelaxed (ω large) states is

$$N_1 = \omega\bar{t} = \omega\eta/G. \tag{5}$$

This introduces the exponential term, since the viscosity can be expected to vary with temperature as $\exp H/RT$; and it is now in dimensionless form, so that it might reasonably be expected to enable results to be transferred from one metal to another by ascertaining suitable values of η and $\bar{G}$. The nalogy with Reynolds's criterion for the transition om non-turbulent to turbulent states as the flow elocity is varied is very attractive. The analogy is arried still further by the fact that, in the viscous rain-boundary system, the shapes of the transition urves for elastic modulus and damping capacity epend also upon the dimensionless ratio G_R/G_u, ust as the friction factor depends upon the roughess ratio as well as the Reynolds number. This atio G_R/G_u has been shown by Zener[6] to depend nly on the Poisson ratio.

This method of approach does not, however, enable he effect of grain-size to be introduced; but a ethod based on Ke's own argument may be used or this purpose. If a crystal is supported a distance away from another crystal by a liquid of viscosity , and a shear stress τ is applied to it, it will move ith a steady velocity

$$v = \frac{\tau \, . \, d}{\eta}. \tag{6}$$

he relaxation time $\bar{t}$ is proportional to the time for he crystal to move with velocity v a distance proortional to the amount of elastic shear in its own ross-section, namely, a distance $D\tau/\bar{G}$, where D is he mean dimension of the crystal. Hence

$$\bar{t}' = D\tau/v\bar{G} = D \, . \, \eta/d\bar{G}. \tag{7}$$

he corrected dimensionless parameter is thus

$$N_2 = \omega\bar{t}' = \frac{\omega \, . \, D \, . \, \eta}{d\bar{G}}, \tag{8}$$

o that the effect of grain-size enters as the dimensioness ratio of the grain-size to the boundary-layer hickness. Since the latter is almost certainly indeendent of the grain-size, N_2 is the dimensionless orm of Ke's parameter (1). It will be of considerable nterest to see whether the results can be transferred rom one metal to another by means of this paraeter, either by deriving a value of η, the effective rain-boundary viscosity for each metal, or, by eriving a value of η/d, the coefficient of boundary lip. From the point of view of dimensional analysis ither is, of course, suitable, because d, the boundaryayer thickness, is likely to be a property of the articular metal concerned, since Mott's work[7] shows hat the boundary is merely a surface of contact of wo crystals. Mott's paper further leads to the uggestion that for different metals η/d should be a unction of the dimensionless quantity H/L, where is the latent heat of fusion. In any event, however, imilarity theory may provide a useful link between e's empirical formula and fundamental theory, if it an be shown that the values of η/d necessary to ring the results for different metals on to the same urve represent properties of these metals which ppear also in other phenomena.

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Dissociation Energy of Carbon Monoxide

A SUMMARY of the various recent views on the dissociation energy of carbon monoxide is given by Gaydon[1] in his "Dissociation Energies", in which he eliminates all proposed values except 11·11 and 9·85 eV., and finally accepts the former as being the more probable. At about the same time, Kenty, Aicher, Noel, Paritsky and Paolino[2] observed a new band system of molecular oxygen in a gas discharge containing carbon dioxide which suggested a lower limit for D (CO) of 9·4 eV. Since then, Hagstrum[3] has defended his electron-impact value of 9·6 eV., Gĕro[4] through Valatin[5] still retains faith in 6·9 eV., and Brewer, Gilles and Jenkins[6] have made a determination of the heat of sublimation of graphite which indirectly supports 11·1 eV. Due to this confusion, which has now persisted for some time, the spectroscopic method of evaluating dissociation energies is in danger of being regarded with cynicism by those physical and organic chemists who urgently need this constant for carbon monoxide. The trouble lies in the lack of any dissociation continuum in the spectrum of carbon monoxide, and accordingly attention has been centred on predissociation phenomena, of which there seems no lack.

I have been working on the electron configurations of the various excited states and have been attracted by the F$^1\Pi$-state. This has such a large $x\omega$ (198 cm.$^{-1}$) that it has probably the flattest potential energy curve of all the states of carbon monoxide and consequently the smallest D value. A linear extrapolation gives 0·5 eV., and if we know the dissociation products it is clear that D for the ground state can be determined without appealing to predissociation. Now this state is definitely a singlet because of the high intensity of the F $\leftarrow X^1\Sigma$-transition, and consequently must dissociate into either two triplet atoms ^3P(C) + ^3P(O) or two singlets. The former possibility can be ruled out, and the most probable pair of atoms is ^1D(C) + ^1D(O). The energy difference between ^3P(C) + ^3P(O), the ground-state products, and ^1D(C) + ^{1}D(O) being 3·3 eV., we find 9·6 eV. for D(CO), and if we allow 0·3 eV. as a possible error in the extrapolation of the F-state, the D-value will be uncertain by this amount. This estimate is in agreement with either the predissociation value of 9·85 eV. or Hagstrum's 9·6 ± 0·1 eV., and leads to a value for L(C) of 130–140 kcal.

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OF the many values which have been suggested for D(CO), the high value of 11·1 eV. and Hagstrum's value of 9·61 eV. seem most likely, as recently pointed out[1]. Dr. Howell's discussion of the F$^1\Pi$-state certainly gives strong support to the latter value. It should be remembered, however, that Birge–Sponer extrapolations for highly excited states may not be reliable, and indeed may be quite anomalous, as for silver hydride. Also it is likely that for the excited states of carbon monoxide there may be potential maxima, and the limit of the extrapolation will then be the maximum instead of the dissociation limit. In the reaction zones of flames much of the light emission is due to chemiluminescence, and it is not easy to account for this unless we are able to postulate reactions which are highly exothermic and which require the high value for D(CO). The 9·61 value would, however, give a more satisfactory comparison with the iso-electronic molecule N_2, for which I favour a dissociation energy of 9·76 eV.

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Thixotropic Behaviour of Petroleum Jelly

IN my earlier communication[1] I directed attention to the reversible change of consistency brought about by the slow and fast shear of petroleum jelly. The present note embodies more precise observations, but it is evident that further work still is needed to interpret the mechanism of the phenomena.

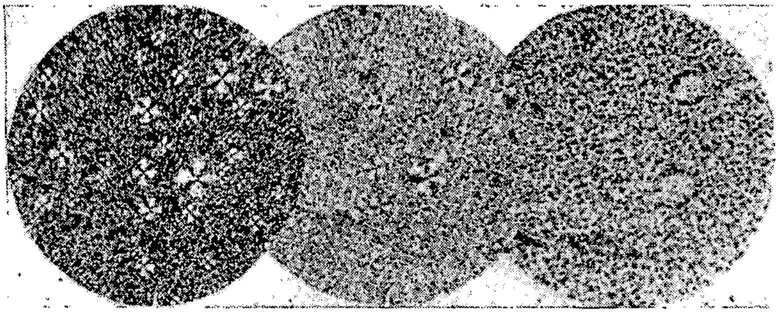
When threshold rigidities are measured in a modified form of parallel-plate plastimeter, reproducible values are not obtainable on the bulk material which has been melted and allowed to cool, owing to heterogeneity of crystalline disposition throughout the mass. However, treatment for a few hours in a slow-running Werner–Pfleiderer mixer reduces rigidity to the minimum value characteristic of slow churning. A parallelism between the results obtained by churning and by treatments under more accurately specified conditions is shown in the following table:

Rigidities by parallel-plate plastimeter

1.	After 2 hours in Werner–Pfleiderer mill	15 dynes/cm.^{2}
2.	Followed by two successive shears through a glass capillary at 35,000 dynes/cm.^{2} stress	57 ,,
3.	Treatment (2) followed by capillary shear at 1,350 dynes/cm.^{2} stress	38 ,,
4.	Treatment (2) followed by capillary shear at 2,700 dynes/cm.^{2} stress	41 ,,
5.	Treatment (2) followed by capillary shear at 5,200 dynes/cm.^{2} stress	48 ,,

It is evident from the fact that treatment (3) has not resulted in reducing the rigidity to its original value that the number of operations was inadequate and/or the shear stress was too high to effect a complete reduction of rigidity to the value shown by (1). In all cases shear was kept well below the limit of incidence of turbulent flow.

I have already referred[2] to a thixotropic anomaly in the capillary shear of petroleum jelly, but uncertainty as to the significance of 'yield value' obtained as an intercept of the stress-shear line to the stress axis does not justify its discussion in the present communication.


(a) (b) (c)

Liquid crystals in milled petroleum jelly (× 50). (a) Nicols crossed, black field; (b) nicols in phase, white field; (c) unpolarized light

It is interesting to note that prolonged treatmen in the Werner–Pfleiderer mixer results in the formation of liquid crystals.

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[1] [*Nature*, **163**, 248 (1949).]

[2] "The Measurement of Plasticity", in "The Science of Petroleum" 1115 (Oxford University Press).

Auroral Displays at Saskatoon

A VERY intense auroral display was observed a Saskatoon during the night of January 24–25. Th display began as a red aurora at 6.15 and the re colour persisted until 7.45; all times mentioned ar Mountain Standard Time (seven hours behin G.M.T.). Some red was present at all times up t midnight. At 7.30 the display consisted of two re sheets in the east and west, and a beautiful coron near the zenith. The corona was green overhead, an red near the eastern and western borders. Thre homogeneous arcs were present at 8.00, one in th north at altitude 15°, a second passing throug the zenith, and a third in the south at altitude 10° All auroral forms were present at some tim during the display, which lasted until dawn Newspaper reports indicate that the red auror was seen in British Columbia and as far south a California.

A second intense display occurred during the nigh of February 21–22. Again all auroral forms appeare during the display, and some red colour was observe at times. During most of the night an arc passin through the zenith extended from horizon to horizon At times this arc was extremely bright.

A photograph of the sun's surface taken at noo on January 24 showed a large sunspot group abou two days past the solar meridian. On February 2 this group was still present although considerabl reduced in size.

A new high light-gathering power grating spectrograph was put into operation for the first time o February 21. This instrument gives a dispersion o 20 A./mm. A four-hour exposure gave a spectrogra which included two weak features at the position of $H\alpha$ and $H\beta$.

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STATISTICAL MECHANICS OF SOME CO-OPERATIVE PHENOMENA

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THERE are a number of co-operative phenomena associated with specific heat singularities for which the technical mathematical problems are formally similar. These include the Ising model of a ferromagnetic, the theory of regular binary solid solutions, and the order–disorder transitions in alloys. Many approximations have been devised for treating these problems, and as a typical example we may quote the Bethe approximation[1]. It was at first considered that these approximations provided a satisfactory account of the thermodynamics of the problems. Recently, however, the exact solution of a particular problem by Onsager[2,3] has shown that the standard approximations are unreliable in the neighbourhood of the singularity, and has focused attention on exact solutions.

It is clarifying to consider the above problems collectively, and in a recent paper[4] it has been shown that, if only nearest neighbour interactions are taken into account, the thermodynamic properties are completely determined by a function $\Lambda(\mu, z)$ of two positive variables μ and z. For the ferromagnetic problem, the free energy is given (except for a zero-order term) by

$$F = -nkT\,[\log \Lambda(\mu, z) - \tfrac{1}{2} \log \mu], \tag{1}$$

where $z = \exp(-\varepsilon/kT)$, $\mu = \exp(-2mH/kT)$, and ε is an interaction energy. In the regular solution and order–disorder problems, the corresponding free energy is

$$F' = -nkT\,[\log \Lambda(\mu, z) - \alpha_1 \log \mu], \tag{2}$$

where μ now depends on α_1, the mole fraction of constituent 1, and is determined by the relation

$$\mu\Lambda_\mu/\Lambda = \alpha_1. \tag{3}$$

It is easy to establish the relation

$$\mu^{-1/2}\,\Lambda(\mu, z) = \mu^{1/2}\,\Lambda(1/\mu, z), \tag{4}$$

and this means that only values of μ from 0 to 1 need be considered. The ferromagnetic and regular solution problems correspond to values of z between 0 and 1, and we shall discuss them shortly. The order–disorder and anti-ferromagnetic problems correspond to values of z^{-1} between 0 and 1, and we shall not consider them further here.

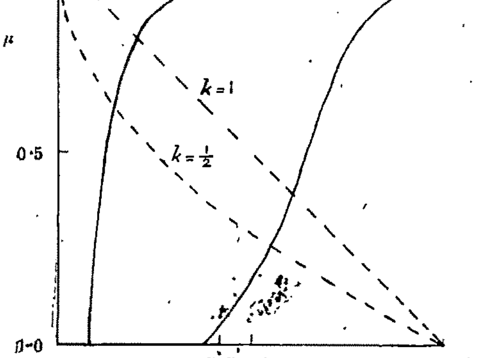

Fig. 1

It is well known that a one-dimensional system does not exhibit sharp phase transitions[5], and therefore, to obtain information of interest, we must proceed to a two-dimensional system. In the paper referred to above[4], a generalization of some earlier work of Kramers and Wannier[6] shows that $\Lambda(\mu, z)$ is the largest eigenvalue of an infinite matrix of simple characteristic structure. A discussion of the properties of $\Lambda(\mu, z)$, and hence of F and F', is best undertaken with the aid of Fig. 1, which represents the (μ, z) plane. Onsager's solution applies to the line AB, and starting at A (corresponding to $T = 0$) a power series may be derived, of which the first terms are the following:

$$\Lambda(1,z) = \lambda(z) = 1 + z^4 + 2z^6 + 5z^8 + 14z^{10} + 44z^{12} + 152z^{14} + \ldots \tag{5}$$

This series is valid up to the Curie point C ($z = 0{\cdot}414$) and gives rise to a logarithmic infinity in λ_{zz} (specific heat singularity) at C. The following generalization of this series for values of μ other than 1 has been obtained:

$$\begin{aligned}\Lambda(\mu,z) = {} & 1 + \mu z^4 + 2\mu^2 z^6 + (-2\mu^2 + 6\mu^3 + \mu^4)z^8 + (-14\mu^3 + 18\mu^4 + 8\mu^5 + 2\mu^6)z^{10} + \\ & (8\mu^3 - 77\mu^4 + 44\mu^5 + 40\mu^6 + 22\mu^7 + 6\mu^8 + \mu^9)z^{12} + (98\mu^4 - 370\mu^5 + 40\mu^6 + 138\mu^7 + \\ & 134\mu^8 + 72\mu^9 + 30\mu^{10} + 8\mu^{11} + 2\mu^{12})z^{14} + \ldots\end{aligned} \tag{6}$$

Substitution of $\mu = 1$ in (6) gives back (5), so this series seems to be valid up to $\mu = 1$, and there is no discontinuity in Λ at $\mu = 1$. On the other hand, we can deduce from (4) that $\Lambda_\mu/\Lambda = 1/2$ at $\mu = 1$, whereas from (6) $\Lambda_\mu/\Lambda \rightarrow \beta(z)$ as $\mu \rightarrow 1$, where

$$\lambda(z)\beta(z) = z^4 + 4z^6 + 18z^8 + 82z^{10} + 387z^{12} + 1880z^{14} + \ldots \tag{7}$$

Thus there is a discontinuity in Λ_μ as $\mu \rightarrow 1$ in the neighbourhood of A, which one would expect to persist as far as C. High-temperature expansions starting at B indicate (as one would expect) that this discontinuity does not persist beyond C.

Onsager's solution for $\mu = 1$ corresponds to a ferromagnetic in the absence of a magnetic field, and values of $\mu < 1$ correspond to the presence of a magnetic field. The magnetization is given by $-\partial F/\partial H$ in (1), and hence by

$$I/I_\infty = 1 - 2\mu\Lambda_\mu/\Lambda. \tag{8}$$

Thus the discontinuity in Λ_μ gives rise to a spontaneous magnetization

$$I_0/I_\infty = 1 - 2\beta(z), \tag{9}$$

which is shown as a function of z in Fig. 2. In the presence of a constant magnetic field, the thermodynamic properties are obtained by following a curve of the form $\mu = z^k$, where k is a measure of the strength of the field. A study of the terms of (6) for values of $\mu < 1$ indicates a completely different behaviour from that for $\mu = 1$, caused by the large negative term in the coefficient polynomials in μ. This is shown by the accompanying table.

For $\mu = 1$, the terms are all positive and steadily increase, and this means a singularity on the real

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Coefficient of:	z^4	z^6	z^8	z^{10}	z^{12}	z^{14}
$\mu = 1$	1	2	5	14	44	152
0·9	0·9	1·62	3·41	7·39	16·04	32·19
0·8	0·8	1·28	2·20	3·35	3·21	−5·48
0·7	0·7	0·98	1·32	1·10	−1·44	−10·92

axis[7]. On the other hand, for $\mu = 0{\cdot}7$ and $0{\cdot}8$, the terms cease to increase steadily, and there are strong indications that for any $\mu < 1$ the coefficients are not consistent in sign beyond some point. This leads one to conjecture that the specific heat transition becomes continuous in the presence of a magnetic field, which is also the result given by the Heisenberg theory.

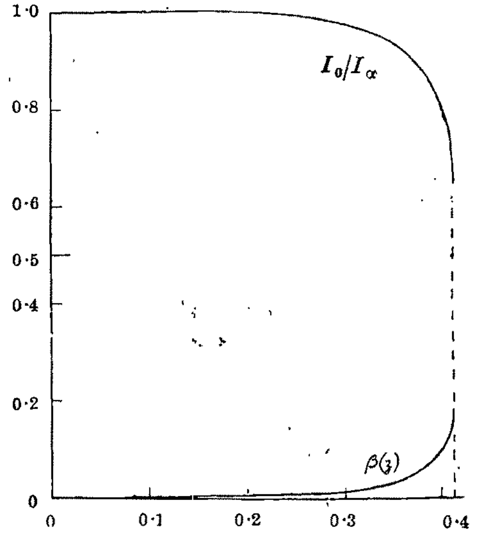

Fig. 2

The exact theory of binary solid solutions was considered by Lassetre and Howe[8], and we shall find many of their conclusions here substantiated. Considering the thermodynamics of a solid solution of fixed constitution, we must follow a path in the (μ, z) plane given by (3). When $\alpha_1 = 1/2$, this is the path AB in Fig. 1. When α_1 is different from 1/2, however, a completely different type of path results. When $z < 0{\cdot}414$, the general behaviour of $\mu\Lambda_\mu/\Lambda$ as a function of μ is similar to the curve in Fig. 3 (for $z = 0{\cdot}4$). Its value steadily increases from zero at $\mu = 0$ to $\beta(z)$ at $\mu = 1$, and there is a jump to 1/2 at $\mu = 1$. This discontinuity arises for an infinite lattice, and would be a very rapid continuous change for a large finite lattice. Hence if $\beta(z) < \alpha_1 < 1/2$, the relation (3) can only be satisfied on the line AB. For very high temperatures it can be shown that (3 leads to $\mu = \alpha_1/(1-\alpha_1)$. Thus for any value of α different from 1/2, the path given by (3) moves alon AC until $\beta(z) = \alpha_1$, and then it turns into the plan cutting BE in a point $\mu = \alpha_1/(1-\alpha_1)$. Typica paths are $A\,C_1\,B_1$, $A\,C_2\,B_2$ in Fig. 1.

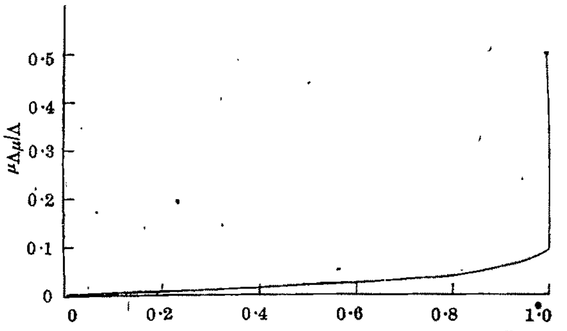

Fig. 3. ($z = 0{\cdot}4$)

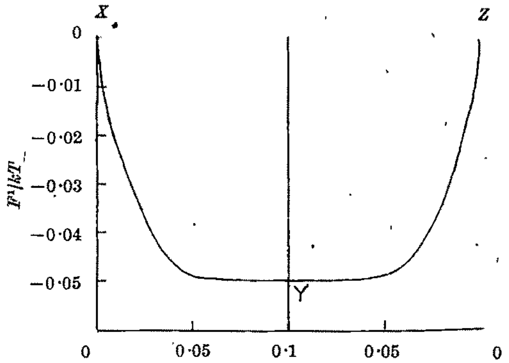

Fig. 4. ($z = 0{\cdot}4$)

Clearly a transition takes place at points such a C_1, and we shall interpret the portion AC_1 as corresponding to a separation into two phases, and th portion $C_1 B_1$ as solution. This interpretation i borne out by the curve of free energy as a functio of concentration, which for $z < 0{\cdot}414$ is of the form shown in Fig. 4. The point on AC in Fig. 1 corresponding to the value of z considered may b regarded as a mixture of two phases at Y in Fig. 4 phase I being a solution of $\beta(z)$ of substance 1 i substance 2, and phase II a solution of $\beta(z)$ of substance 2 in substance 1. $\beta(z)$ is thus the maximum concentration which can exist in solution at the give temperature, and is, in fact, the solubility curve fo the given substances; it is shown in Fig. 2. A we move along AC_1, the proportion of phase I gets smaller, until at C_1 it disappears.

The nature of the transition at C_1 can be determined from (2) and (3). There is a discontinuity i μ_z at C_1 given by

$$\underset{\mu\to 1}{Lt}\ \frac{\alpha_1\,\Lambda_z - \mu\Lambda_{\mu z}}{\mu\,\Lambda_{\mu\mu} + (1-\alpha_1)\Lambda_\mu}. \qquad (10$$

On the other hand, $(F'/T)_\mu = 0$, so that $E = n\varepsilon z\,\Lambda_z/\Lambda$, and this does not involve μ_z. Thus th energy is continuous, but the specific heat has discontinuity given by

$$nk(z\log z)^2\ \underset{\mu\to 1}{Lt}\left[\mu_z \frac{\partial}{\partial_\mu}\left(\Lambda_z/\Lambda\right)\right], \qquad (11$$

so that the transition is second order.

It does not seem unreasonable to assume that with the exception of the detailed behaviour at th singularity C, the above discussion should be qualitatively applicable to a three-dimensional model.

I am indebted to Prof. M. H. L. Pryce and Dr G. S. Rushbrooke for helpful discussion and to th Department of Scientific and Industrial Research fo a senior research award.

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TUMOURS ASSOCIATED WITH A VIRUS INFECTION IN AN INSECT

By F. T. BIRD
Division of Entomology, Department of Agriculture, Ottawa

REPORTS of tumours in insects are relatively rare. Paillot[1] mentions proliferation in the fat cells of *Euxoa segetum* Schiff., following infection by virus diseases (pseudo-grasseries I and II). Tumours have been described in the fruit-fly, *Drosophila melanogaster* Meigen, by Stark[2,3,4] and Russell[5]; in larvæ of the Pygæra group of butterflies, by Federley[6]; and in the stick insect, *Dixippus morosus* Br., by Pflugfelder[7]. They have been found in a large Orthopteran insect, *Leucophæa maderæ* F., by Scharrer[8].

All the tumours so far discovered in insects are apparently non-malignant, although malignancy has been claimed by Stark[2] and Federley[6]. Russell[5] found that those in *Drosophila* reported by Stark as malignant were similar in structure to benign tumours occurring in the same insect, and that the so-called malignant tumours could be successfully transplanted without hampering the development of the host. The tumour strains discovered by Federley apparently have been lost.

Various stimuli will provoke tumour proliferations in insects. Spontaneous tumours occur in several genetic tumour strains in the fruit-fly, but the stimulus is not known. Russell suggests that certain abnormalities which occur in the mid-gut epithelium of the lethal 7 strain may cause abnormal cell proliferations. In the stick insect, proliferation accompanies cell degeneration following the removal of the corpora allata, organs of internal secretion. In *Leucophæa*, Scharrer has shown that tumours are formed in the mid-gut and salivary reservoir, and to a less extent in the fore-gut and salivary glands, when the recurrent nerve, which innervates these organs, is cut at various levels.

In the course of a study of a virus polyhedral disease of the European spruce sawfly, *Gilpinia hercyniæ* (Htg.)[9], tumours were observed in the mid-gut after infection of the epithelium by the virus. The following is a brief description of the origin and nature of the tumours, pending a more detailed account of the disease to be published elsewhere.

The mid-gut epithelium of the normal sawfly larva is made up of large columnar digestive cells, a basement membrane, an inner circular and an outer longitudinal muscle coat. The lattice work of muscle fibres covers but a part of the epithelial cells; in many places these are separated from the circulating blood only by the basement membrane and a delicate connective tissue sheath. Among the large digestive cells there are groups or *nidi* of small basal, embryonic or regenerative cells located just beneath the basement membrane. The function of the regenerative *nidi* is (1) to propagate cells, (2) to replace the large cells when the latter are exhausted by digestive activities, (3) to add to the number of digestive cells during the moulting periods of young larvæ, and (4) to replace the digestive epithelium at the time of the last larval moult and during pupation.

During the moulting period of a young larva, new cells are passed gradually from the regenerative *nidi* into the digestive epithelium. This is accomplished without any appreciable increase in the size of the *nidi*. At the time of the last larval moult, the digestive epithelium is completely replaced. The digestive cells disintegrate slowly and at the same time there is an increase in the number of cells of each regenerative *nidus*. A new mid-gut is formed when adjacent *nidi* converge. All the cells do not enter into the functional epithelium. A few remain at the bases of the digestive cells, where they form the regenerative *nidi* of the new mid-gut. Most of the materials of the old larval gut are absorbed, but an indigestible part is evacuated after ecdysis. Soon after this evacuation, the larva spins a cocoon and at this stage is termed an eonymph. The mid-gut of the eonymph is similar to that of the young larva. It is a temporary gut, however, and soon the digestive cells again disintegrate, and cells are propagated by the regenerative *nidi* to form the adult mid-gut.

In the diseased larva, the virus affects only the digestive cells of the mid-gut epithelium. When infection takes place and nuclear transformations occur which finally result in the formation of polyhedral bodies, abnormal cell proliferations appear in the regions of the regenerative *nidi* (Fig. 1). There is no increase in the size of the *nidi* at this time. Apparently a few cells are released and multiply rapidly to form the proliferations. Most of these project into the body cavity, but infiltration into the cytoplasm of the digestive cells does occur. This is similar to, but more intense than, that which takes place during the moulting period of a healthy larva.

Large tumours are formed only when the larva becomes infected just prior to the last larval moult. All the materials necessary for further metamorphosis

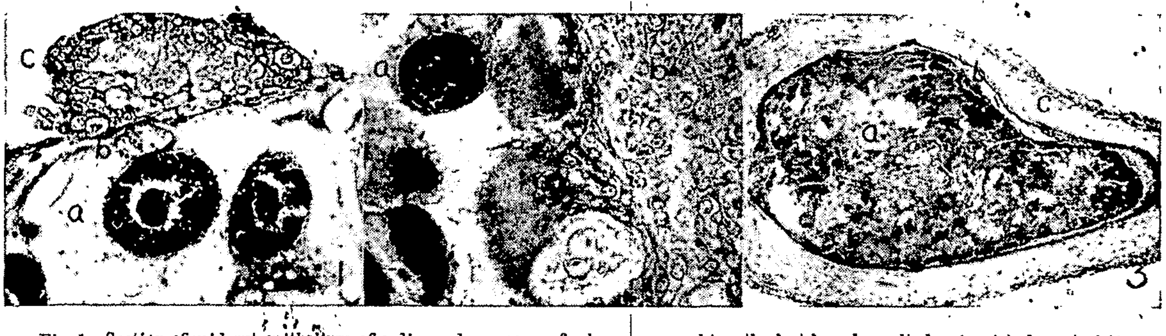

Fig. 1. Section of mid-gut epithelium of a diseased spruce sawfly larva approaching the last larval moult showing (*a*) characteristic granulation of nuclear material as a result of disease infection, (*b*) regenerative *nidus*, and (*c*) proliferating cells. × 270

Fig. 2. Section of mid-gut epithelium of an eonymph showing (*a*) disease nuclei and (*b*) proliferating cells. × 270

Fig. 3. Section of a mature tumour of the spruce sawfly showing (*a*) necrotic mass of epithelial origin, (*b*) thin layers of tissue formed from proliferating cells, and (*c*) a loose mass of proliferating cells. × 45

are accumulated at this time, and normal cell proliferation and replacement takes place. When larvæ become infected at an earlier stage, death from the effect of the disease occurs before these abnormal proliferations progress very far. The infection process and abnormal cell proliferations continue in the eonymphal gut. The sizes of the tumours depend on the areas of cell infection. In the case of total infection there is a general swelling of the entire eonymphal gut. The centre of a growing tumour consists of an accumulation of dead cells. This is surrounded by greatly enlarged infected cells. The whole is surrounded by a mass of proliferating cells (Fig. 2).

The tumours rapidly mature during an early stage of pupation. Cell infection and abnormal cell proliferation cease at the time of the normal disintegration of the digestive cells of the eonymphal gut. General infection takes place after the adult gut is formed, but from the time of the breakdown of the eonymphal digestive epithelium until the adult gut is formed cell infection by the virus appears to be inhibited. If the infection process and tumour formation have not continued too far, a normal gut may be formed around the tumours and the insect survives. Many of the tumours remain within the gut during pupation. Because the mid-gut of the adult is much shorter than that of the eonymph, some of the tumours may be pushed out into the body cavity during pupation, where they remain as non-living, hard, dark-brown pellets throughout the life of the adult. Those which remain within the gut are subject to the action of digestive juices and may disappear. The mature tumour consists of a necrotic, pigmented mass of epithelial cells surrounded by thin tissue layers formed from the small proliferating cells (Fig. 3).

There is no evidence of infiltration of the tumour cells into any other organ in the spruce sawfly. All the evidence indicates that the tumours are non-malignant.

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SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

THE fifty-third annual congress of the South-Eastern Union of Scientific Societies was held at Canterbury during April 19–23, at the invitation of the Mayor and Corporation, with the co-operation of the Dean and Chapter.

In his address the president, Mr. F. H. Edmunds, district geologist for south-east England in the Geological Survey, gave a broad picture of the evolution of State Geological Surveys in the various countries of the world. He indicated how their inception, in the first half of the nineteenth century, was intimately linked with the birth and growth of the science of geology, which itself is but some 150 years old. The basic principles of geological science were formulated largely as the result of the work of James Hutton in Scotland and William Smith in England; Smith produced the first real geological map. Once these principles had been grasped, the economic importance of the geological map became immediately apparent to Governments everywhere. The Geological Survey of Great Britain was established in 1835, and it was almost immediately followed by those of Canada and India. To-day practically every civilized country in the world possesses its Geological Survey.

Mr. Edmunds said that geological research is the scientific study of the foundation of all our surroundings, and its application touches us, either directly or indirectly, in our everyday life in many directions one obvious way is in assisting in the discovery of economic minerals—coal, oil, minerals, etc.—and there are also numerous other less apparent ways Geological maps of a country which give detailed accurate data of the surface layers of the land are particularly valuable in densely populated countries in connexion with the many and widespread civi engineering works which are always in progress and which vary from foundation work for buildings to bridge-building, road-making and surface water storage, reservoir and dam-building, and from digging trenches for water, gas and sewage mains to sinking wells for water supply. Geological Surveys have also a cultural function, instanced by the identification by the Geological Survey of Great Britain of the types of rock and, in many cases, of their sources, which were used in making archæological objects, such as thos revealed in bombed sites in Canterbury during the Second World War.

As social development proceeds towards planning and nationalization, as it is doing in Great Britain the influence of the work of a Geological Survey on the implementation of policies becomes very great Again quoting Great Britain, Mr. Edmunds said tha not only was the Geological Survey the officia adviser to the Coal Board, but its work also provides the basic data for decisions by central and loca planning authorities relative to such matters as wher and how sand, gravel, building stones, brick, cement etc., should be quarried or manufactured; indeed, n other basic criteria exist. The search for natura reserves of underground water has long been the function of the Geological Survey; without this previous work, regulation and conservation of underground water, now rendered necessary largely owin to great increases in daily consumption, would be impracticable.

An address on "Roman Canterbury" was delivered to the Archæological Section by its president, S. S Frere, who also conducted a tour of the recent excavations in the City to illustrate points in his address. The keeper of manuscripts at the Cathedral Library, W. Urry, gave a paper on "The Street Plan of Mediæval Canterbury", and later demonstrated t the members on site. Excursions to Minster, Ebbsfleet, Sandwich and Richborough were conducted by Dr. H. Raven. Dr. George Taylor became president of the Botanical Section, the subject of his address being "Remarks upon the Genus Potamogeton" Francis Rose gave a paper upon "Gaps in our Knowledge of the Flora of Kent", and conducted an excursion to Stodmarsh and Trenley Park Wood.

The president of the Geological Section, Arthur Wrigley, spoke on "The Thanet Sand", and conducted an excursion to Bishopstone Gap to examine the Lower Eocene rocks. A paper on "Notes on th Minerals of the Mesozoic and Later Strata of S.-E England" was given by J. C. Taylor. A joint cursion with the Botanical Section to demonstrate e agricultural soils of Kent was conducted by . S. Furneaux.

The Zoological Section, under the presidency of ajor Maxwell Knight, held a symposium on Nature udy, with particular reference to the need for -operation between the museum, laboratory and ld-worker. The leaders on the Stodmarsh–Trenley rk Wood excursion were D. Stainer and R. G. illiams, and the Rev. Laurens Sargent led the ction on an expedition to the estuary of the Stour ar Richborough. An evening was devoted to a nversazione arranged by the local committee. The hibits included manuscripts shown by the Dean d Chapter and the charters of the King's School. and, freshwater and marine life in all sections were splayed.

The 'Young Naturalists' Evening' commenced with 'brain's trust' consisting of a team of experts, C. Bushby, Dr. L. B. Langmead, F. Rose and David th Smith, with Major Maxwell Knight as question aster. Many questions received from students of cal schools were answered. An exhibition of Nature ms taken at the London Zoo by Douglas Fisher as enthusiastically received by an audience from e schools, the hall being filled to capacity.

The next congress will be held jointly with the uth-Western Union at Marlborough during Whitntide, 1950.

NATIONAL ACADEMY OF SCIENCES, UNITED STATES

THE National Academy of Sciences at its annual meeting held in Washington, D.C., during April –27, elected the following officers, members and reign associates.

Vice-president for a four-year term ending in 1953: dwin Bidwell Wilson, emeritus professor of vital atistics, Harvard School of Public Health, Boston, ass.

Members of the Council of the Academy for a three-ar term ending in 1952: Joel H. Hildebrand, ofessor of chemistry, University of California; rnest W. Goodpasture, professor of pathology and an, School of Medicine, Vanderbilt University.

Members: George W. Bartelmez, professor of atomy, University of Chicago; Frank A. Beach, ofessor of psychology, Yale University; Robert B. rode, professor of physics, University of California; aul R. Burkholder, Eaton professor of botany, Yale niversity; Lowell T. Coggeshall, professor and airman, Department of Medicine, and dean, ivision of Biological Sciences, University of Chicago; ax Delbrück, professor of biophysics, California stitute of Technology; Robert C. Elderfield, pro-ssor of chemistry, Columbia University; William F. ibbs, vice-president, Gibbs and Cox, 240 East 79th treet, New York; William W. Hansen, professor of hysics, Stanford University; Charles B. Huggins, rofessor of surgery, University of Chicago; Walter . Lambert, U.S. Coast and Geodetic Survey (retired), ashington, D.C.; Howard B. Lewis, professor and ead of Department of Physiological Chemistry, niversity of Michigan; Francis W. Loomis, pro-ssor and head of Department of Physics, University f Illinois; Thomas S. Lovering, U.S. Geological urvey, Washington, D.C.; Samuel M. McElvain, professor of chemistry, University of Wisconsin; Saunders MacLane, professor of mathematics, University of Chicago; Nicholas U. Mayall, Lick Observatory, Mt. Hamilton, California; Otto Meyerhof, research professor of physiological chemistry, University of Pennsylvania; John S. Nicholas, Sterling professor of biology, Yale University; George B. Pegram, professor of physics and dean of graduate faculties, Columbia University; Kenneth S. Pitzer, professor of chemistry, University of California; Kenneth B. Raper, senior microbiologist, Northern Regional Research Laboratory, U.S. Department of Agriculture, Peoria, Illinois; John L. Savage, chief designer, U.S. Bureau of Reclamation, Denver, Colorado; Carl F. Schmidt, professor of pharmacology, University of Pennsylvania; Julian Schwinger, professor of physics, Harvard University; Harry L. Shapiro, professor of anthropology, Columbia University; Oliver R. Wulf, professor, Division of Chemistry and Chemical Engineering, California Institute of Technology; Ralph W. G. Wyckoff, scientist director, National Institute of Health, Bethesda, Maryland; Frederick W. H. Zachariasen, professor and chairman of the Department of Physics, University of Chicago.

Foreign Associates: Élie Cartan, professor of geometry, University of Paris; Paul A. M. Dirac, Lucasian professor of mathematical physics in the University of Cambridge; Bernard Lyot, astronomer, Meudon Observatory, Seine-et-Oise, France; Henri Piéron, Laboratory of Physiological Psychology, Sorbonne; Arne Tiselius, professor of biochemistry, University of Uppsala; Öjvind Winge, director, Department of Physiology, Carlsberg Laboratory, Copenhagen; Hideki Yukawa, professor of physics, Kyoto University, Japan.

Awards for 1948

The Academy has made the following awards for 1948.

Cyrus B. Comstock Prize of 3,500 dollars: to Dr. Merle Anthony Tuve, director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, for his pioneering work on the upper atmosphere and his development of the electrical impulse method of study; for his pioneering work in nuclear physics utilizing the electrostatic generator; and for his development of the proximity fuse.

James Craig Watson Gold Medal: to Dr. Samuel Alfred Mitchell, director for more than thirty years of the Leander McCormick Observatory of the University of Virginia, for distinguished services to astronomy, including (1) observations of solar eclipses, in particular a detailed study of the spectrum of the chromosphere which has contributed notably to knowledge of the atmosphere of the sun; (2) determination of the magnitudes of eight thousand comparison stars in 450 fields containing long-period variables, and more than fifteen thousand observations (with others) of 204 of the variables themselves; (3) trigonometrical measurement of the parallaxes of some fifteen hundred stars.

Mary Clark Thompson Gold Medal: to Dr. Frank McLearn, of the Geological Survey of Canada, in recognition of his important contributions to geological knowledge in a number of fields.

Public Welfare Medal: to Prof. George Harrison Shull, emeritus professor of botany and genetics, Princeton University, for his services in the application of principles of the pure line and of hybrid vigour to the improvement of the quantity and quality of the maize crop.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. J. Cole, F.R.S.: "Aspects of Biological Discovery, 3, Life Cycle of a Parasite".*

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. Johannes Brøndsted (Copenhagen): "Tribes and Peoples in Scandinavia during the Stone and Bronze Ages".* (Further Lectures on May 18 and May 20.)

Monday, May 16—Thursday, May 19

International Institute of Welding (at the University, Delft, Holland).—Annual Meeting.

Tuesday, May 17

Society of Chemical Industry, Agriculture Group (in the Chemistry Department, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Dr. J. G. Davis: "The Scientific Basis of Cheese-Making".

Chadwick Public Lecture (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Prof. C. T. Ingold: "Spore Dispersal in relation to Plant Disease and Health".*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Margarete Weninger: "Anthropological Research Work in Austria".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. J. L. Nicholson: "Variations in Working-Class Family Expenditure".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. C. Branch and Mr. J. L. Sweeten: "The Fabrication of Chemical Plant in Stainless Steel".

University of London (at Birkbeck College, Breams Buildings, London, E.C.4), at 6 p.m.—Sir John Anderson, F.R.S.: Haldane Memorial Lecture.*

Wednesday, May 18

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Alfred Egerton, F.R.S.: "Scientific Information Services" (Aldred Lecture).

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "The General Circulation of the Atmosphere" (to be opened by Dr. E. T. Eady).*

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Discussion on "Mechanism of Cell Division" (to be opened by Dr. A. F. W. Hughes).

Society of Chemical Industry, Nutrition Panel of the Food Group (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Discussion on "The Nation's Manufactured Foods, 2, Biscuits, Cakes and other Flour Confectionery as Food".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. A. L. Hetherington: "Chinese Ceramic Glazes, with special reference to the Copper Glazes".

Thursday, May 19

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting; at 5.15 p.m.—Mr. W. A. C. Newman: Presidential Address.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. M. J. Lighthill: "A Technique for Rendering Approximations Uniform".

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8 p.m.—Annual General Meeting.

Friday, May 20

Chemical Society, Exeter Branch (in the Washington Singer Laboratories, University College, Exeter), at 4.30 p.m.—Sir Ian Heilbron, F.R.S.: "A New Approach to the Synthesis of Azoles and Purines".

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—"Air Navigation".

Physical Society, Acoustics Group (at the Royal College of Organists, Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. L. E. A. Bourne: "The Development of a new Electronic Organ".

Society of Dyers and Colourists (at the Waldorf Hotel, Aldwych, London, W.C.2), at 7.15 p.m.—Mr. E. Wilson: "Some Applications of Chemistry to Textile Finishing" (Sixth Mercer Lecture).*

Saturday, May 21

British Psychological Society (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Dr. Otto Friedmann: "Psychopathology and Politics".

APPOINTMENTS VACANT

Applications are invited for the following appointments on before the dates mentioned:

Lecturer in Physics (with an Honours Degree in Physics)— Clerk to the Governors, Woolwich Polytechnic, Woolwich, Lond S.E.18 (May 21).

Lecturer (Grade III) in Applied Mathematics—The Clerk, B beck College, Breams Buildings, London, E.C.4 (May 21).

Teacher of Mathematics with ability to teach Physics and other Science subjects for classes which may reach Degree stand and a Senior Assistant for Physics—The Principal, Munic Technical College, Halifax (May 21).

Laboratory Technician—The Secretary, Mid-Glamorgan Hosp Management Committee, 8 Wind Street, Neath, Glam. (May 21)

Assistant Inspector of Salmon Fisheries—The Establishm Officer, Scottish Home Department, Room 364, St. Andrew's Hou Edinburgh 1 (May 21).

Lecturer in the Civil and Mechanical Engineering Depa ment (to teach mechanical engineering subjects, preferably includ Applied Thermodynamics *or* Engineering Drawing and Design) Engineering Degree and National Certificate courses, and a Lectur in the Applied Physics Department—The Secretary, Northamp Polytechnic, St. John Street, London, E.C.1 (May 21).

Lecturer in Mathematics and Science (either Chemistry Physics)—The Principal, Dudley and Staffordshire Technical Colle Dudley (May 21).

Senior Lecturer in Mathematics—The Clerk to the Govern Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 21).

Engineer III (Instructor) at a Ministry of Supply factory in M mouthshire—The Ministry of Labour and National Service, Techni and Scientific Register (K), York House, Kingsway, London, W.C quoting C.231/49A (May 21).

Lecturer in the Department of Chemistry, to teach Orga Chemistry to the standard of B.Sc. Special Degree, in the Plymou and Devonport Technical College—The Director of Education, Edu tion Offices, Cobourg Street, Plymouth (May 21).

Chair of Geography at the London School of Economics a Political Science—The Academic Registrar, University of Lond Senate House, London, W.C.1 (May 25).

Senior Analyst—The City Analyst, City Laboratories, Mou Pleasant, Liverpool 3 (May 28).

Lecturer in Bacteriology, and a Lecturer or Assista Lecturer in the Department of Biochemistry—The Registr The University, Sheffield (May 28).

Assistant Lecturer in Physics—The Principal, Royal Hollow College, Englefield Green, Surrey (May 28).

Senior Lecturer in Psychology (General Psychology with spec emphasis on Educational Psychology) in the University of Melbour —The Secretary, Association of Universities of the British Commo wealth, 5 Gordon Square, London, W.C.1 (May 30).

Lecturer in Biochemistry—The Secretary, Royal (Dick) Vet inary College, Summerhall, Edinburgh 9 (May 31).

Director of the National Institute of Oceanography—T Secretary, Civil Service Commission, Scientific Branch, 27 Grosven Square, London, W.1, quoting No. 2549 (June 3).

Lecturer (male) in Botany in the Imperial College of Trop Agriculture, Trinidad—The Secretary, Imperial College of Trop Agriculture, 40 Norfolk Street, London, W.C.2 (June 30).

Macleay Bacteriologist—The Secretary, Linnean Society of Ne South Wales, Science House, Gloucester Street, Sydney, N.S.W Australia (June 30).

Laboratory Technicians in the Departments of (*a*) B chemistry, (*b*) Biological Chemotherapy and Tropical Medicin and (*c*) Bacteriology with Immunology—The Administrat Officer, National Institute for Medical Research, Hampstead, Lond N.W.3.

Research Physicist to undertake investigations on semi-conduct materials—The Professor of Physics, The University, Reading.

Assistant Teacher in the Chemistry Department, to tea Physics and Mathematics, in the Bolton Municipal Technical College The Chief Education Officer, Education Offices, Nelson Square, Bolt

Lecturer in Mechanical Engineering—The Clerk to the Gove ing Body, Battersea Polytechnic, Battersea, London, S.W.11.

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Chemists and Physicists—The Director, Paint Research Statio Waldegrave Road, Teddington, Middx.

Senior Officer to supervise and develop the work in the Chemic Section, a Secretary to group of Committees dealing wi Mechanical Engineering subjects, a Secretary to group of Committe dealing with Radio subjects, and a Committee Secretary (male female) with general technical background—The Director, Briti Standards Institution, 28 Victoria Street, London, S.W.1, endors 'Technical Assistant'.

Laboratory Assistant (mainly for work in Electrical and Mecha ical Engineering laboratories)—The Principal, Maidstone Techni College, Tonbridge Road, Maidstone, Kent.

Graduate (preferably with research experience in biochemistry chemistry) to assist in investigations on intermediary metabolism The House Governor and Secretary, Royal Cancer Hospital, Fulha Road, London, S.W.3.

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BRITISH COLONIAL GEOLOGICAL SURVEYS

PLANNED co-operation in the development of backward areas may well serve modern needs better than unrestricted and often wasteful competition; and this applies particularly in connexion with the mineral development of vast, virtually unexplored regions such as are presented by the continent of Africa. The recent proposal to supplement various Colonial Surveys, particularly in Africa, by American geologists, therefore, deserves careful consideration. In commercial work there has at times been considerable collaboration between geologists of all English-speaking countries, as evidenced during the copper development period in Northern Rhodesia, when millions of subscribed capital were spent on exploration by the companies concerned. The results that they obtained were not, however, generally made public; there is no published map of the special areas which were explored in that large territory.

The present proposal takes for granted that there is, and will be for some time, a serious shortage of geologists in Great Britain and the Dominions. As to the competence of the geologists of the British Commonwealth there can be no doubt; the Dominions and Colonies have been well served indeed by their official Surveys, wherever these exist and where they have been adequately supported. The tempo is now to increase; the support to be given them will be greater.

Many of the problems of geological survey, especially in Africa, are not such as would confront a commercial company. Their study may not lead to immediate results. The work of a geological survey is never finished. There is not merely the question of an intensive search for economic minerals. There are problems of soil erosion, water supply, irrigation, structures, structural materials and hydro-electric problems, the location of land for agricultural needs, and the supply of essential mineral fertilizers. Where minerals are concerned, one is not necessarily considering the immediate exploitation of an economic asset. It is the function of a State Geological Survey to study what may be called 'strategic reserves' of minerals which may not be capable of being put to economic use for some time, or which, for reasons of national policy, it may not be desirable to disperse or even to discuss publicly. This has not infrequently led to conflict of opinion between big business interests, which generally have a relatively narrow outlook, and Government officers, whose duty it is to take a longer and more impartial view.

There are therefore some very practical questions to be answered before embarking on the wholesale recruitment of geologists from the United States for work on Colonial Surveys. Such survey work is a long-term operation for Governments, not short-period research for a company. Will American colleagues working with a Colonial Survey in, say, Africa, be content to abide by the rules of an alien service? Will they be ready to lease or lend their national loyalty ? Will they be content to spend long periods of their lives away from their own land, where opportunity and prosperity are still within reach of many ? If not, what is to compensate for breaks in continuity of their work ? Africa is not to be learned in a day.

Remuneration for such services in the United States is on a much higher scale than is customary in British Colonial or Dominion Geological Surveys. If, in the latter, it had been more generous in the past, there would no doubt be a less obvious shortage of British geologists now. Is it intended to scale up the rate of pay in these services, or are American geologists to receive an additional subsidy from their own or other Government concerned ? The position may perhaps be summarized in the reply of at least one Geological Survey to a question regarding aid from the Office of European Economic Co-operation, in which the services of American experts were offered. In effect, it said that the needs and proper programme of that Survey had been painfully apparent for many years; what was required was money to carry them out.

Given adequate funds and sympathetic support, it should not take too long to attract and train men from the Commonwealth and Great Britain to their own geological services. For long-term work, as opposed to an immediate need, this is what is required ; and the United States could render great service by helping in the part-training of such men in their own institutions and methods. It would be better to benefit by American generosity in this way than to subsidize American geologists to spend short periods under British administration, perhaps in competition with their fellow-professionals. True co-operation should not, in Kipling's telling phrase, become involved in "the business end of the American invasion".

Industrial competition within the United States has caused, and is still causing, an excessive waste and dispersal of irrecoverable raw materials. Any new discoveries of minerals in other lands should not be drawn into the mill of American productivity before a reasonable brake and limit has been set on the expenditure of such materials. This can only, and must ultimately, be attained by international agreement.

The development of backward areas through the collaboration of American personnel must needs bring with it some preference for American machinery and equipment, and some priority in the allocation to the United States of the raw materials produced. The law "to him that hath shall be given" has a sound philosophical basis, just as the problems of the concentration and dispersal of matter have their counterpart in the second law of thermodynamics. The need of the world to-day is that there should not be too much concentration of any one thing in one particular area, while providing for an adequate supply everywhere. If collaboration has this end in view, it is to be welcomed. Is it invidious to suggest that, concurrently with the development of backward areas, and the relieving of distressed ones, a modest form of rationing of some raw materials should be accepted in the New World ?

THE NURTURE OF RESEARCH

The Genius of Industrial Research

By D. H. Killeffer. Pp. ix+263. (New York
Reinhold Publishing Corporation ; London : Cha
man and Hall, Ltd., 1948.) 27*s.* net.

IN the ever-growing literature dealing with industri
research, comparatively little attention has bee
given to the mental characteristics needed for researc
work and whether the training given at universiti
and technical colleges tends to develop adequatel
these qualities. In "Glances at Industrial Research"
E. R. Weidlein and W. A. Hamor look beyond th
walls of the Mellon Institute to the broader pr
fessional aspects of industrial research. These prol
lems are briefly considered by Dr. D. W. Hill
"Co-operative Industrial Research" ; but were virtu
ally ignored by Sir Frank Heath and A. L. Hetherin
ton in "Industrial Research and Development".
more adequate discussion is to be found in "Th
Future of Industrial Research", issued four years ag
by the Standard Oil Development Co. ; but apa
from highly suggestive passages in Col. L. E. Simon
"German Research in World War II", it is to th
scientific and technical periodicals that we must loo
for the more penetrating discussions of the qualiti
required in industrial research and the methods b
which they are best fostered. Some of the post-w
reports, like Dr. Vannevar Bush's "Science—th
Endless Frontier" and that of the Barlow Committe
on Scientific Staff, or statements from Nuffiel
College, have made some contribution ; but by an
large the most useful and fundamental contributio
are widely scattered and probably not easily assemble

Clearly the subject is one that demands som
consideration at the present time, when the relati
contribution of the technical colleges and of th
universities is in debate, and Sir Lawrence Bragg
address on "The Standards of Advanced Studies ar
Research in Science and Technology", recently pu
lished in the *Universities' Quarterly*, will doubtle
provoke some discussion on the issues which
clarifies. In the present volume, Mr. Killeffer's trea
ment is too superficial to make any real contributio
to elucidating the qualities which are essential
success in industrial research or the way in whic
they are best fostered. His book is a treatise c
the technique of research and some factors tha
determine success in industrial research, rather tha
a discussion of the genius or real nature of research
it indicates to the undergraduate the range of exper
ence he may encounter and some of the techniqu
he should develop if he enters on a career in industri
research, rather than suggests to a teacher the wa
in which the inherent abilities of a student may be
be nurtured for success in that field.

Mr. Killeffer's diffidence over the term 'geniu
indicates that he is half aware that his title is il
chosen. He does not distinguish very clearly betwee
fundamental, or academic, research and industri
research, and some of his categories of the latter ad
nothing to his argument. This would be less importa
if Mr. Killeffer recognized that the creative mind
which are always rare, are required in both academ
and industrial research. It is from them that th
real advances come, nor are such men and wome
always the eccentrics that Mr. Killeffer implies. Oft
they take their place in a team, whether as units
as leaders, quite as harmoniously as their less talent
colleagues.

Success in industrial research, in Mr. Killeffer's view, appears to be mainly a matter of methodical thinking, systematic organisation and wise choice of objectives rather than one of inspiration. His prime purpose in writing the book is, by analysing the methods of thought and procedure followed by some outstanding investigators, to display principles that may guide the young investigator to a clearer understanding of the nature of research, and increase his competence. He has accordingly compiled a thoroughly representative collection of first-hand accounts of such work, largely from addresses of Perkin medallists and the like, including such pre-eminent investigators as Langmuir, Genslager, Midgley, Cottrell, Twitchell, Sabatier and R. Williams, and ranging over such varied fields as gas-filled lamps, rubber accelerators, refrigerants, high-octane petrol, synthetic rubber, vitamin B_1, to J. E. Teeple's work on potash recovery and E. Weston's on nickel-plating. The result should have been a source book of industrial research which could take a worthy place beside other volumes in the well-known series published by the McGraw-Hill Book Co.

The accounts, though full, are, however, abridged and are interspersed with comments or explanations by Mr. Killeffer himself. Good as some of this material is, Mr. Killeffer has not left himself the space to deal really effectively with such matters as pilot-plant development, report writing, patents and the evaluation of results, on each of which he has short chapters. While abridgment has robbed the records of something of the effect of full contact with original minds, Mr. Killeffer has not succeeded in making good the defect himself, as is well shown by his chapter, "Thinking out the Problem", in which the whole question of scientific method is dismissed too cursorily; and little awareness of the major contributions to modern thought on that subject is revealed. His own contribution is less than that of F. R. Bichowsky in an earlier book, "Industrial Research".

How great an opportunity has been missed by thus falling between two stools may best be realized by comparing the book not merely with the 'source-book' series already mentioned and such outstanding lectures as F. R. Japp's Kekulé Memorial Lecture, or the Hoffman Memorial Lectures of Lord Playfair, W. H. Perkin or H. E. Armstrong, but also with autobiographies or biographies of the quality of Sir J. J. Thomson's "Recollections and Reflections" or Dr. A. S. Eve's "Rutherford". If Mr. Killeffer had learned the lessons of such works, the present volume might well have taken different shape.

For the rest, the book firmly assaults the popular myth that the processes of scientific and technical advance are mysterious and akin to the methods of the magician. Mr. Killeffer says surprisingly little about the qualities making for successful team-work which have been emphasized in such war-time achievements as radar, atomic energy, penicillin and the like. He recognizes the value of imagination and the ability to see beyond mere surface indications; but his stress is laid, in the main, on those qualities of intelligence and orderly thought and the acquisition of techniques which can be developed by efficient and thorough training as the indispensable minimum for success in industrial research. Without these, or without the help of other workers who possess them, genius itself may be ineffective in industry.

Mr. Killeffer's book may provoke some profitable discussion, and he may have blazed a trail for a more adequate and inspiring source-book. Whether university professors, even in the United States, will find that they can use the book for educational purposes remains to be seen. Mr. Killeffer has at least opened up the subject further; but it is to be hoped that those who follow in his trail will avoid the time-wasting practice of relegating all bibliographical references to the end of the book, instead of placing them where they are normally sought and found by the reader.

R. BRIGHTMAN

DISCUSSION ON ISOTOPES

Institut International de Chimie Solvay: Rapports et discussions sur les isotopes

Septième Conseil de Chimie tenu à l'Université de Bruxelles, du 22 au 27 septembre 1947. Pp. iii+411. (Bruxelles: R. Stoop, 1948.) N.p.

THE first Chemical Congress of the Solvay Institute took place in Brussels in 1922; ensuing Congresses were held at regular intervals of three years until 1937. At each of them, men of science from various countries presented authoritative reviews on topical subjects, and the printed reports of these meetings are still a valuable source of information. It was, therefore, very welcome news when it became known that, after the war-time interruption, the Seventh Chemical Solvay Congress would be arranged in Brussels in the autumn of 1947, under the chairmanship of Prof. P. Karrer (Zurich). Its subject was "Les Isotopes".

The "Reports and Discussions" of the Congress have now been published in a stately volume of more than 400 pages. As was to be expected from the general title chosen, very different sides of the question of isotopes have been under review at Brussels. Prof. F. Joliot (Paris) dealt with "Modes de formation, constitutions et filiations des isotopes, notamment des isotopes artificiels"; Prof. K. T. Bainbridge (Harvard) with "Some Results of Mass-Spectrum Analysis". There followed two papers on the spectroscopy of isotopes; Prof. C. K. Ingold (London) gave a résumé on "Isotopes in the Spectroscopy of Polyatomic Molecules with Special Reference to the Benzene Molecule", and Prof. M. de Hemptinne (Louvain) spoke on "Les isotopes comme moyen d'investigation des spectres de bandes". The next two lecturers paid attention to the chemical technique, Prof. F. A. Paneth (Durham) discussing "The Preparation of Radioactive Tracers", and Prof. A. Langseth (Copenhagen) "The Preparation of Organic Deuterium Compounds". The last three reports were almost exclusively devoted to biological uses of the tracer technique. Prof. G. de Hevesy (Copenhagen) described the "Application of Labelled Phosphorus", Prof. M. Calvin (Berkeley, Cal.) "Radiocarbon and its Application in Chemistry and Biology", and Prof. D. Rittenberg (New York) "The Use of ^{15}N and D for the Study of Chemical Processes in the Living Cell".

This enumeration of the titles will provide some means of gauging the wealth of information contained in the volume, too rich indeed to be briefly abstracted. It is to be added that a Solvay Congress, with its limited number of specialist members and generous allowance of time, provides a particularly good setting for fruitful discussions; in these not only "les membres rapporteurs", the principal speakers, participate, but also the scientific secretaries of the Solvay Foundation and a dozen or so invited guests. Their joint efforts represent a scientific contribution by no means less valuable than the introductory reports, and Prof. J. Timmermans, the secretary of the scientific committee, and his helpers are to be congratulated especially on the excellent way in which the discussions of 1947 have been seen through the press—no easy task, since the speakers dispersed immediately after the Congress was over, and their scattered notes had to be co-ordinated. That the two official languages of the Congress, French and English, have been printed equally well is perhaps not more than most people are inclined to take for granted in a Brussels publication.

F. A. P.

ROCKET PROPULSION: PAST, PRESENT AND FUTURE

Rockets and Space Travel

The Future of Flight beyond the Stratosphere. By Willy Ley. Pp. viii+374+14 plates. (London: Chapman and Hall, Ltd., 1948.) 18*s*. net.

SINCE the earliest times, man has dreamed of the possibility of leaving this planet to visit the heavenly bodies, and much has been written around this theme, ranging from the satirical and fantastic to the serious and scientific. This book is an encyclopædic survey in a readable and untechnical style of every aspect of the subject.

The author begins by discussing the numerous imaginative stories of journeys to the moon and stars which have been written throughout the ages. Of these, the best known are probably Lucian's "Vera Historia", Kepler's "Somnium", Cyrano de Bergerac's "Voyage dans la Lune", and the novels of Jules Verne and H. G. Wells. The development of rockets is then described. It appears that the earliest mention of rockets which can be traced is contained in a Chinese chronicle which records their use at the siege of Pien-king in A.D. 1232. Soon after that date they were used by the Arabs and in Europe. At the end of the eighteenth century, Hydar Ali and his son Tippoo Sultan successfully employed them against the British in India, and this led to the considerable improvements in rocket design and performance made by Sir William Congreve, and to the establishment of the British Rocket Corps, which distinguished itself on the Continent in the early part of the nineteenth century. From about 1850 until the First World War, rockets as a weapon of war suffered a decline because of the great advances made in artillery.

The tide then turned, and between the two Wars considerable progress in rocket development was made, chiefly in America by Goddard and in Germany by the Verein für Raumschiffahrt, of which the author was vice-president. He gives a most interesting first-hand, though probably not entirely unbiased, account of the fortunes of this Society and of the personalities of its leading members, such as Oberth, Valier and Hohmann, and of others, such as von Opal and Ganswindt. During the recent War, rocket development advanced at an extremely rapid pace, and the book contains chapters in which the chief rockets used by the Americans, British and Germans are described.

For Mr. W. Ley the chief interest of rockets lies in the possibility of their use as a means of escaping from the earth's gravitational field, and he devote a considerable part of his book to a discussion of space-travel and its problems. The theoretical work of Hohmann and others is described, and numerous diagrams are given in order to illustrate the best and most economical routes to and round the moon and planets, the techniques of landing and other point of astro-navigation. Figures and tables based on various fuels and propellant-mass ratios are quoted and other problems, such as the effect of gravity and acceleration on the human body, are not neglected. One may not share Mr. Ley's idealism and enthusiasm; but one cannot help admiring the thoroughness with which he investigates, and generally overcomes, all the objections and difficultie which arise.

The volume is exceedingly well documented throughout; perhaps one of its most valuable part is the extensive bibliography of books and pamphlets in which are listed about 150 works in English French, Russian and Italian, ranging from th technical and mathematical to the historical and fictional.

R. A. RANKIN

A MODERN COUNTY FLORA

A Geographical Handbook of the Dorset Flora

By Prof. Ronald Good; including a Chapter on th Soils of Dorset, by K. L. Robinson. Pp. xi+255 (Dorchester: Dorset Natural History and Archæological Society, 1948.) 20*s*.

THE facts of distribution of the flowering plant of Britain are to be found in a long series o county floras which we owe to the flair and enthusiasm of the amateur field botanist. These facts have been the material for wider speculation on and more detailed study of the factors determining the origin and controlling the distribution of the flora. Th names of Forbes, Watson, Stapf, Matthews and Salisbury may remind us of the interest of such contributions. Prof. R. Good's book is unique in combining the facts of the typical county flora with a consideration of general and special problems o distribution.

Its predecessor, Mansel-Pleydell's "Flora of Dorsetshire", was published in 1895 and is a good example of its kind. It is interesting to compare it with Prof. Good's "Handbook". In the earlier book, preliminary matter runs to 37 pages and 345 are given to the lists of plants. In the later, the lists of plants take jus one half of 255 pages. In both there is a short account of topography and geology. Prof. Good also deals with climate and includes a useful and modern account of soil types and distribution from the pen of K. L. Robinson. Mansel-Pleydell gives some tables comparing the Dorset flora with that of neighbouring regions. Prof. Good has written a lucid account of the origin of various groups of native plants and discusses the status of 47 adventive species.

But the most interesting part of the work, and that which is entirely fresh, is a detailed account of the distribution of plants within the county. There is an introduction on general principles and a brief section on the climatic factor. Climate seems to be the major factor controlling the distribution of about a hundred species. For most plants, however, edaphic factors are decisive, and the effects of these are dealt with in great detail. Finally, there is a chapter on plants the distribution of which cannot be related to any one dominating factor, and, here, suggestion is accompanied by indications of problems needing further research. The general treatment is throughout pointed by reference to a selection of individual species, and is illustrated by thirty maps. Readers of Prof. Good's "Geography of the Flowering Plants" will recognize in all this the foundation of chapter 13 of that work.

It is clear that this admirable treatment could not have been based on the older type of record. It has been made possible only because the author himself undertook a systematic survey which lasted over nine seasons. In the course of this the occurrence of more than 600 species was recorded for 7,500 stands —an average of seven to nine stands to the square mile. This was a great task, and its effects are seen in the number and spacing of the dots on the distribution maps. From all this has come the present book. It includes the customary plant lists. It is also an original and valuable contribution to plant geography and a signpost to new pastures for the ield botanist.

M. Skene

PROGRESS IN BIOCHEMISTRY

Annual Review of Biochemistry

Edited by J. Murray Luck, Hubert S. Loring and Gordon Mackinney. Vol. 17. Pp. ix+801. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 6 dollars.

WHEN the "Annual Review of Biochemistry" first appeared in 1932 it was born almost at its present size, for the first volume, of 724 pages, was little smaller than the latest. Nourished by an increasing diet of publications, the "Review" might have grown alarmingly; but, partly by feeding portions to the newer "Annual Reviews" of physiology and microbiology, the editors have successfully kept it down. The exuberance of biochemistry is such, however, that further procrustean treatment is necessary, and, in 1950, plant material will be removed into a new "Annual Review of Plant Physiology". The wisdom of this decision is perhaps confirmed by the article on plant hormones in the present volume, which contains quite a long section on the control of weeds.

The service rendered by the "Review" to biochemistry is widely appreciated and frequently acknowledged; nevertheless, the present writer cannot forgo the privilege of offering his own grateful thanks. The function of the reviewer of these volumes is limited; he is in danger of preaching to the converted; and he can serve best by trying to attract the attention of uninitiated workers in related fields. He can also indicate what, in his opinion, are the strengths and weaknesses of the volume under review. This volume follows the familiar pattern, with articles on enzymes and on the chemistry and metabolism of the fundamental biochemical substances, with the addition of chapters on more specialized topics. This time the latter include the chemistry of the immunopolysaccharides, X-ray crystallographic studies of compounds of biochemical interest (showing the help given in the elucidation of the structure of penicillin), clinical applications of biochemistry (serum potassium, phosphatases, blood iodine, liver function), metabolism of drugs and toxic substances, clinical aspects of vitamins, biochemistry of carcinogenesis (including the metabolism of carcinogenic substances, factors influencing carcinogenesis and tissue changes in neoplasia), terpenes (especially of the genus *Pinus*), alkaloids, photosynthesis, mineral nutrition of plants, plant hormones, chemistry of penicillin (a 'brief' summary of 41 pages and 216 references), ruminant digestion (tracing the formation and utilization of the volatile fatty acids) and physiological aspects of genetics (featuring the obliging *Neurospora*, viruses and many other organisms, including man). Despite the existence of the "Annual Review of Microbiology", there is an article on bacterial metabolism, a welcome provision for macrobiological chemists wishing to keep in touch. Lack of space prevents the present writer from describing the contents of all these articles, but the titles indicate the importance and fascinating nature of the subjects reviewed.

Reduction in size could be accomplished by stricter editing and control of the scope of each review. Thus, xanthine oxidase is considered in "Nonoxidative Enzymes" as well as in "Biological Oxidations and Reductions"; catalase is discussed in two articles and acetate metabolism in four. "Clinical Aspects of Vitamins" contains matter and formulæ more suitable for a text-book, shows the structural formula of pteroylglutamic acid twice, and contains such statements as, "We must know more of the mechanism of the carcinogenic action of all the factors promoting and retarding the production of tumors", and "In deficiency of vitamin A, certain specific pathologic changes are observed in the epithelial structures. Eventually they give rise to what can be termed vitamin A deficiency."

The subject index is regrettably inadequate. Whereas the author index extends to thirty three-column pages, the subject index consists of only nineteen two-column pages. It occupied fifty pages in 1945. A really comprehensive subject index would add enormously to the value of the work, and if it involved delay in publication, this would be justified. Few textual errors were noted, but "Staphlocoagulase [*sic*], an enzyme from pathogenic streptococci" (p. 38), one misprint on p. 21, two on p. 35 and one on p. 209 may be cited.

Perhaps the greatest problem of the contributors is that of welding brief references to large numbers of papers into readable accounts. This year they have been particularly successful. In addition, combining wise saws with their modern examples, many have made profound remarks designed to clear up current muddled thinking, or have warned against the abuse of modern techniques by the unskilled and the unwary. A discussion of nomenclature is a valuable feature of at least two articles.

Finally, the deft touch is not lacking; we are informed that the blood group enzyme acts not only on Negro erythrocytes but also on those of diseased Caucasians; while the statement that "tocopheryl phosphate removes the calcium that activates the nucleotidase that destroys the coenzyme that catalyzes the oxidation of malate to oxaloacetate", although it may have to be modified slightly in view of later work by Pardee and Potter, brings back happy memories of a childhood spent when life, and biochemistry, were so much simpler.

G. D. Greville

Elsevier's Encyclopædia of Organic Chemistry

Edited by R. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12*B*: Naphthalene; *A*. Compounds containing One Naphthalene Nucleus; Hydrocarbons and Halogen Compounds. Pp. xxx+344+22. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1948.) To subscribers to whole work, £6 5*s*. 0*d*.

THIS is actually the first part of vol. 12*B*, for it deals only with hydrocarbons of the naphthalene series, their hydrides and the halogen compounds. The much larger number of other derivatives, together with compounds containing more than one naphthalene nucleus, will presumably form the subject of one or more further parts. Series 3 of the 'Encyclopædia' will then be complete, for vols. 12*A*, 13 and 14 have already been issued (for a general description of the whole project, see *Nature*, 161, 415; 1948). The present volume maintains the standard of excellence of its predecessors; but the rate of progress is behind schedule, and considerable acceleration will be needed if the work is to constitute an up-to-date compendium of organic chemical compounds.

It is stated in the preface that references up to the end of 1944 have been included in this volume, and, as far as the reviewer has been able to determine, the bibliography is complete. More important publications of 1945–47 are also noted. In addition to its attractive lay-out, the book has many pleasing features, including the useful summaries of data given in many tables, the generous use of neatly printed structural formulæ to illustrate reactions, and the sure chemical instinct exemplified by a number of cogent editorial comments. The sections dealing with the more important compounds, such as naphthalene and its monomethyl and monohalogeno derivatives, tetralin, decalin, cadinene and selinene, form readable and informative articles. The volume may be commended to the attention of all organic chemists, whatever their specific fields of interest.

J. W. COOK

Géométrie descriptive à quatre dimensions

Par J. Maurin. Livre 1: Figures du premier degré. Chapitres 1, 2, 3: Définitions, positions, intersections. Pp. 38. (Paris: Libr. Gauthier-Villars, 1948.) 200 francs.

THE reviewer approached this volume in a mood of reflexion as to the proper place in the general scheme of geometrical study for four-dimensional geometry. His own introduction to the concepts of geometry of more than three dimensions was through the excellent volumes of M. Jonffert ("Traité Elémentaire de Géométrie à Quatre Dimensions", 1903; and "Mélanges de Géométrie à Quatre Dimensions", 1907). Though interested, he felt an acute disappointment in the natural limitations therein, which was not overcome until, long after, Bertini's work came to his hands. He therefore read M. J. Maurin's volume with a prejudice that, for the geometer, the general n-dimensional case should be first studied and the four-dimensional enlarged upon later.

M. Maurin, in pointing out the peculiar importance of four-dimensional geometry in the study of some mechanical phenomena, makes a strong case for its independent consideration. The present volume is limited to definitions and the study of the intersections of lines and of planes. His method of presentation is an extension of the method of Monge and is amply illustrated by diagrams which occupy half volume. The range is too restricted for the rea to obtain any estimate of the ultimate value of method of approach, but the author suggests t interesting developments will be found in la volumes, which are much looked forward to. In vi of his special plea for the importance of fo dimensional study it would have been well if a lit more space had been devoted in the introduct pages to initial ideas; the first few paragraphs so condensed that the student with no previ knowledge will find them insufficient for his und standing.

H. GWYNEDD GREEN

X-Ray Optics

The Diffraction of X-Rays by Finite and Imperf Crystals. By A. J. C. Wilson. (Methuen's Monograp on Physical Subjects.) Pp. vii+127. (Londo Methuen and Co., Ltd., 1949.) 6*s*. net.

THIS work fully maintains the standard that now expected from this well-known series. T author has set himself well-defined limits, has stat these clearly in the preface, and has treated t subject-matter within these limits in a workmanli fashion. It is unfortunate, therefore, that the ma title of the book is deceptive, and that it has to qualified by a sub-title; a book on X-ray opt should have image formation as its main conten but this subject is not dealt with at all in this boo The author justifies this omission on the groun that crystal-structure determination is closer chemistry than to physics. The reviewer does n agree with this; the results are certainly of chemi interest, but the *methods* are essentially physical.

Apart from the title, however, there is little th one can criticize. The author has collected togeth a variety of problems in the diffraction of X-rays imperfect crystals and has shown how they can treated mathematically. He has taken pains introduce the subject gradually—perhaps too grad ally for those who are able to master the la chapters—and therefore almost everybody will ga something from the book. In addition, the style pleasingly informal. The book can be confiden recommended to those interested in X-ray diffracti particularly to those concerned with the finer detai

The Way of a Plant in Field and Garden

By Gareth H. Browning. Pp. x+141+7 plate (London: Rockliff Publishing Corporation, Lt 1949.) 8*s*. 6*d*. net.

MR. GARETH BROWNING, author of seve works on popular natural history, has writt another little book which seeks to explain the fun tions of the flowering plant in such a way that will be scientifically correct and also intelligible the general reader. From both points of view he h achieved his object, and his book will be of value the non-specialist interested in agriculture, horticult or the natural history of plants. Whether the bo will appeal to them sufficiently to make them wa to buy it is another matter. Authors of success books on popular subjects to-day realize the val of visual appeal and, generally speaking, have set high standard in the range and quality of the pai ings, photographs and diagrams of the illustratio to their books. The seven coloured photographs a thirteen line-drawings in "The Way of a Plant" a not enough, neither are they of a high standard.

T. H. H.

EDWARD JENNER, BENJAMIN WATERHOUSE, AND THE INTRODUCTION OF VACCINATION INTO THE UNITED STATES

By DR. E. ASHWORTH UNDERWOOD
The Wellcome Historical Medical Museum

THE two-hundredth anniversary of the birth of Edward Jenner, the discoverer of vaccination, was celebrated on Tuesday, May 17, by functions in many places, but notably at Berkeley, Glos, his birthplace, at the Royal College of Physicians, the Royal College of Surgeons—where Sir Edward Mellanby gave an address—and the Wellcome Historical Medical Museum. Much of what can be said—within the limits of an article—on Jenner's life and work has already been said. This present tribute to a man to whom mankind owes so much will therefore be concerned mainly with those aspects of his life and work which have some bearing on the introduction of vaccination into the United States. Although these events are well known in America, the important work which Benjamin Waterhouse did is not fully appreciated in Britain. In this brief article, it is impossible to avoid ground which has already been covered in certain American journals.

Jenner's Early Life

Edward Jenner was born at the Old Vicarage, Berkeley, on May 17, 1749. His father was vicar of Berkeley, and his elder brother Stephen was also in Holy Orders. Edward was apprenticed to a surgeon at Sodbury when he was thirteen, and for the next eight years he had excellent practical experience. When he was twenty-one he became a resident house-pupil in the London house of John Hunter, and during the two years while he was a pupil, a friendship developed between Jenner and Hunter, twenty-one years his senior. In 1772, when Jenner seemed set for a London career, he succumbed to the lure of his native county—he was essentially a countryman—and returned to practise at Berkeley. There, with brief interludes, he remained the rest of his life. Until Hunter's death in 1793, he and Jenner corresponded regularly, and the elder man constantly encouraged the younger in natural history pursuits, and as constantly requested specimens of the most varied kind. It was early in this correspondence that Hunter gave Jenner the famous advice: "But why think, why not try the experiment ?"[1]. This encouragement resulted ultimately in Jenner's admirable paper on the habits of the cuckoo[2], in which he described the method whereby the young cuckoo clears the nest of its foster-parent. Often discredited, this work has been completely vindicated in recent years.

Jenner and the Concept of Vaccination

Baron says[3]—probably with truth—that the idea that cowpox could confer protection against subsequent infection with smallpox first entered Jenner's mind when, as an apprentice at Sodbury, he heard a young countrywoman say when smallpox was mentioned in her presence: "I cannot take that disease, for I have had cow-pox". He certainly reflected on this statement, and in later years he was impressed by the fact that, when he was inoculating smallpox matter for 'protective' purposes, the operation was unsuccessful in those who had previously had cowpox. The principle of inoculation was that the individual was given what was hoped would be a mild attack at a convenient time, and was thereby protected against a natural attack of the disease, which was often severe and loathsome, and fatal in as many as 50 per cent of the cases. This practice was introduced by Timoni (1714) and Pylarini (1715); but the effective agent in popularizing it was Lady Mary Wortley Montagu (1721). By Jenner's day it was a common practice. It was a bad method, since the resulting disease was often not mild, and sometimes caused death. Further, each inoculated person acted as a focus for the dissemination of true smallpox.

To return to Jenner. He was well aware of the fact that cowpox was found only in certain counties in Britain, and moreover was present only at intervals. Smallpox, on the other hand, was possibly worst in London, where at that time it was causing a rough average of two thousand deaths annually. Natural cowpox would therefore not be very effective in preventing smallpox in a crowded city where only a few people handled cows. On the other hand, if he could show that cowpox occurring naturally in man could then be transmitted from one individual to another without losing its power to protect against smallpox, there would be no limit to the number of individuals who could be protected. These were the two propositions which Jenner set out to test experimentally, and the results were set out in his "Inquiry into the Causes and Effects of the Variolæ Vaccinæ, a disease discovered in some of the Western Counties of England . . . and known by the name of the Cow Pox". This small book was published in the summer of 1798, and two further editions were published later. I have given elsewhere[4] a critical statement of the genesis and reasoning of this book, and it must suffice to state here that, though the cases were few, they did form a *prima facie* case.

Events Following Publication

After publication of the "Inquiry", Jenner went to London to seek volunteers for vaccination; but though he stayed there three months he was unsuccessful. Vaccination in London was popularized by Henry Cline, who started with some lymph which Jenner gave him; by Dr. Woodville, of the Smallpox Hospital, and by Dr. George Pearson. It was soon evident that Woodville and Pearson were planning to take the whole credit for the introduction of vaccination; but Jenner's equanimity enabled him to stem the tide. Vaccination was soon widely practised in Britain. Various contretemps occurred, many of which Jenner had foreseen. In May 1799, De Carro introduced vaccination to Vienna[5], and German cities soon followed. In January 1800, the "Inquiry" was translated into French, and was published in Paris soon afterwards[6]. It should be remembered that Britain was then at war with France—which explains the delay. Vaccination spread from France to Spain during the latter part of 1800, and it was soon widely practised in most European countries. From the very time when the announcement of the discovery was first made, the emphasis was always on *free* vaccination. By the end of 1799 various attempts had been made in provincial cities to form "institutions for gratuitous inoculation", that is, vaccination[7]. In London, Pearson formed a vaccine board, which was to carry out free vaccination. As early as September 1798, Jenner had been pressed by Henry Cline and Sir Walter Farquhar to take a house in Grosvenor Square; they promised him £10,000 per annum. He declined, and in a letter to a friend at this time he wrote:

"Shall I, who even in the morning of my days sought the lowly and sequestered paths of life, the valley, and not the mountain; shall I, now my evening is fast approaching, hold myself up as an object for fortune and for fame?—Admitting it as a certainty that I obtain both, what stock should I add to my little fund of happiness?

"My fortune, with what flows in from my profession, is sufficient to gratify my wishes; indeed so limited is my ambition and that of my nearest connexions, that were I precluded from future practice I should be enabled to obtain all I want. And as for fame what is it? a gilded butt, for ever pierced with the arrows of malignancy"[8].

Introduction of Vaccination to the United States

The fact that vaccination was introduced into the United States by Benjamin Waterhouse is stated briefly in all works dealing with the history of vaccination. Baron, writing in 1838, had quite a lot to say about the event. But though the work of Waterhouse was recognized in most parts of America and abroad, in Boston, where he spent all his active life, he was half-forgotten. This was due to the fact that he was never popular with the other members of the profession at Boston and Harvard. He was a Quaker, an active controversialist, an opponent of the political party in power, and at heart a scientific man who had perforce to practise medicine. It was the publication of the paper "Waterhouse, the Jenner of America", by William H. Welch, in 1885, that really placed him in his proper place[9]. Welch gives all the relative facts, but for a true appreciation of the various difficulties encountered we must go to Waterhouse's own publications on vaccination[10,11]. These, like other early vaccination tracts, are now very rare. First let us look at the man.

Dr. Benjamin Waterhouse

Benjamin Waterhouse was born in Newport, Rhode Island, on March 4, 1754. His mother was a niece of John Fothergill, the famous London physician, and in due course Waterhouse studied under Fothergill. He also took courses at Edinburgh and for four years at Leyden, where he graduated in 1781. After assisting his uncle for a time he returned to practise in Newport, Rhode Island, in June 1782. A medical college was then being inaugurated in association with Harvard College, and Waterhouse was invited to take the chair of the theory and practice of medicine. He was the first in America to give a systematic course of instruction in botany and mineralogy, and he founded the Botanical Gardens at Cambridge, Mass., and the collection of mineralogy at Harvard. Despite these advances, his unpopularity and the acrimonious disputes in which he was involved led to him being deprived of his chair in 1812. He died at Cambridge on October 2, 1846.

Benjamin Waterhouse
From Lettsom's "Hints", vol. 3 (1801)

In the beginning of 1799 Waterhouse received from his friend John Coakley Lettsom in London a copy of Jenner's "Inquiry". Waterhouse says that the disease cowpox was totally unknown in that part of the world. He goes on: "On perusing this work, I was struck with the unspeakable advantages that might accrue to this country, and indeed to the human race at large, from the discovery of a mild distemper that would ever after secure the constitution from that terrible scourge, the small-pox"[10]. Soon after, he received a copy of George Pearson's book on vaccination, and he sent to the *Columbian Centinel* of March 12, 1799, a short account of the method under the title "Something Curious in the Medical Line". He reprints this article in the first part of his "Prospect"[10]. He says that he wrote the article to direct the attention of the dairy farmers to the existence of cowpox. A few weeks later he showed Jenner's book at a meeting of the American Academy of Arts and Sciences. The president of the United States, John Adams, was at the meeting and was much interested[12]. Waterhouse conceived it his duty, considering his official position in the University, to give the matter a trial. After several unsuccessful attempts to obtain cowpox matter from England, Waterhouse succeeded in getting some from Dr. Haygarth of Bath—this lymph having come from Jenner's stock. With this matter he vaccinated seven members of his own family, and thereafter he invited Dr. Aspinwall, the physician to the smallpox hospital, to inoculate them with smallpox virus. The test was quite successful, though all were not inoculated. He then says that he had laboured to collect all the evidence on this subject, and to lay it "before the American public, in so plain and simple a manner, as to require no other preparation for its admission than common sense and an unprejudiced mind"[10]. Waterhouse had obviously been receiving requests for vaccine matter from professional men, and in an

Lyman Spalding
From J. A. Spalding

ppendix to the first part of his "Prospect", which dated from Cambridge, August 18, 1800, he writes : To those of the faculty who have applied to him y letter *to supply them with matter for inoculation* -He would just observe, that as he has taken much ains in this business, run no small risk of reputation, s well as of personal feelings, there are *few* he trusts, hat will wonder he is anxious to have the matter nder his own eye until the practice is more firmly stablished by the public opinion. Some unsuccessful ases at the beginning, deprived Scotland of the lessing of inoculation for the small-pox for more than 0 years. He hopes this idea will operate as an excuse t present, even in the minds of his *ci-devant* upils.

"Dr. Waterhouse informs those who have applied him out of Cambridge, to inoculate their families, hat he declined it only until the disorder had gone irly through his own family, and until some of them ad been inoculated by Dr. Aspinwall, and otherwise xposed to the small-pox. But having now confirmed is assertion, *that the kine-pox protects the constitution from the infection of the small-pox*, by a fair xperiment, he is ready to attend them whenever ey choose. Those who live in Boston, may rest ssured, that from the proximity of his residence to e capital, he shall make such arrangements as to be ble to attend them as punctually as if he resided ere."

In Part 2 of his "Prospect", published in 1802, aterhouse says that by September 1, 1800, he had accinated about fifty persons. The public attention as now fairly excited, and he was embarrassed by umerous applications for vaccine. But soon everyody believed that the operation of arm-to-arm accination was a simple matter and could be perrmed by anyone. Gone was Jenner's advice on the rrect stage of the vesicle for the withdrawal of lymph ; gone also were Waterhouse's own injunctions. Women and children were encouraged to inoculate each other, and by the autumn of 1800 there was a traffic in cowpox matter by non-professional persons. Waterhouse says : "I have known the shirt sleeve of a patient, stiff with the purulent discharge from a foul ulcer, made so by unskillful management, and full three weeks after vaccination, and in which there could have been none of the specific virus ; I have known this cut up into small strips, and sold about the country as genuine kine-pock matter, and coming directly from me. Several hundred people were inoculated with this caustic morbid poison, which produced great inflammation, sickness, fever, and in several cases *eruptions*, with a greater disturbance of the system than what occurs in the true disease. It is worthy of remark, that I could not influence these people to believe that they had *not* passed through the true disease, and that they were *not* secure from the small-pox."

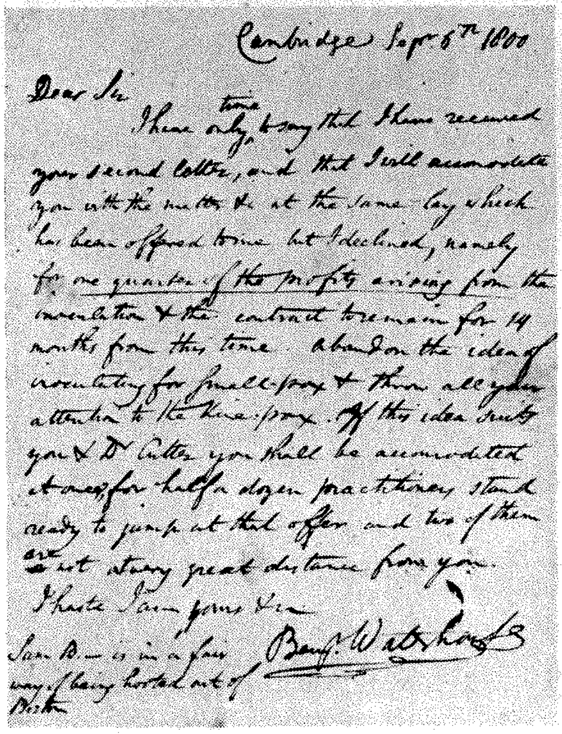
At Marblehead a vessel arrived from London having aboard a sailor supposed to have cowpox. Matter was taken from him and distributed widely, and many cases of smallpox resulted. However, in the winter of 1801, Waterhouse obtained new matter from England, and advice from Jenner. As a result, the practice of vaccination was successfully established in Massachusetts.

Waterhouse always regarded Jenner with the greatest admiration and respect. It is worthy of note that, in a letter which he wrote to Jenner on April 24, 1801[13], Waterhouse tells of the transmission of smallpox to cows. At one of the inoculation hospitals—where smallpox matter was used—several persons drove their cows to the neighbourhood, so that they could be milked for their families in the hospital. The milking was done by persons in all stages of the smallpox. The cows developed eruptions on their teats and udders, "so like the small-pox pustule, that every one in the hospital, as well as the physician who told me, declared the cows had the small-pox".

Dr. Lyman Spalding

During the early stages, when Waterhouse was receiving many requests for vaccine lymph, he had correspondence with Dr. Lyman Spalding. Most of this correspondence was published in a biography of Spalding by his grandson[14]. Some of it has also been re-published, notably by Leikind[15]. As the originals of two of these letters are now in the Wellcome Collection, and as this story is virtually unknown in Britain, they are re-printed here in facsimile. They illustrate an amusing incident, which was perhaps unavoidable in the social atmosphere of that time, but which is not at all representative of Waterhouse's character and of the great work which he did for vaccination and American medicine.

Lyman Spalding[16,17], the originator of the United States Pharmacopœia, was born in Cornish, New Hampshire, on June 5, 1775. As a boy he attracted the attention of Dr. Nathan Smith, who finally had him sent to the Harvard Medical School. He was a pupil of Waterhouse, and graduated in 1797. He assisted Smith in the foundation of the Dartmouth Medical School in 1797, and he gave the first course of chemical lectures when the school was opened. He then studied medicine and practised at Portsmouth, New Hampshire. There he printed yearly bills of mortality, and sent them to the leaders of the profession in America and in Europe. He was well known



Cambridge Sept 6th 1800

Dear Sir

I have only time to say that I have received your second letter, and that I will accomodate you with the matter &c at the same lay which has been offered to me but I declined, namely for one quarter of the profits arising from the inoculation & the contract to remain for 14 months from this time. Abandon the idea of inoculating for small-pox & throw all your attention to the kine-pox. If this idea suits you & Dr Cutter you shall be accomodated at once, for half a dozen practitioners stand ready to jump at that offer and two of them are not at very great distance from you.

I haste I am yours &c

Benjn Waterhouse

Sam B.— is in a fair way of being hooted out of Boston

(*a*) Letter from Waterhouse to Spalding
Original in the Wellcome Historical Medical Museum (39826·1)

as an anatomist and a surgeon, and he was the first in America to inject the lymphatics. In 1810 he was invited to lecture at the Fairfield Medical School in New York State, and in 1813 he became president of the institution. He now established himself in New York City. Even in 1815 he had the idea of a national pharmacopœia ; but it was not until 1820 that he was able to reconcile conflicting interests, and the first edition was published in that year. Spalding died as the result of an accident on October 21, 1821.

Letters in the Wellcome Collection

The two letters to which I referred are reproduced here in facsimile. The texts are as follows :

(*a*) Waterhouse to Lyman Spalding, at Portsmouth (W.H.M.M. (39826·1)) :

"Cambridge, Sept. 6th, 1800.

Dear Sir,

I have only time to say that I have received your second letter, and that I will accomodate you with the matter &c at the same lay which has been offered to me but I declined, namely for *one quarter of the profits arising from* the inoculation & the contract to remain for 14 months from this time. Abandon the idea of inoculating for small-pox & throw all your attention to the kine-pox. If this idea suits you & Dr Cutter you shall be accomodated at once, for half a dozen practitioners stand ready to jump at that offer and two of them are not at very great distance from you.

I haste I am Yours &c

Benjn. Waterhouse

Sam B.— is in a fair way of being hooted out of Boston."

(*b*) Spalding to Waterhouse (W.H.M.M. (39826·2))

"Portsmouth 10 Sept 1800

The terms are accepted, & I promise that you shall have one quarter part of the neat profit arising from my inoculation with the kine pox for the space of 14 months, provided it be not made public before that term expires—& then the contract to remain in full force only to the time of its becoming public however on your part it is expected, that the like priviledge will not be granted to others in my vicinity.

L. Spalding.

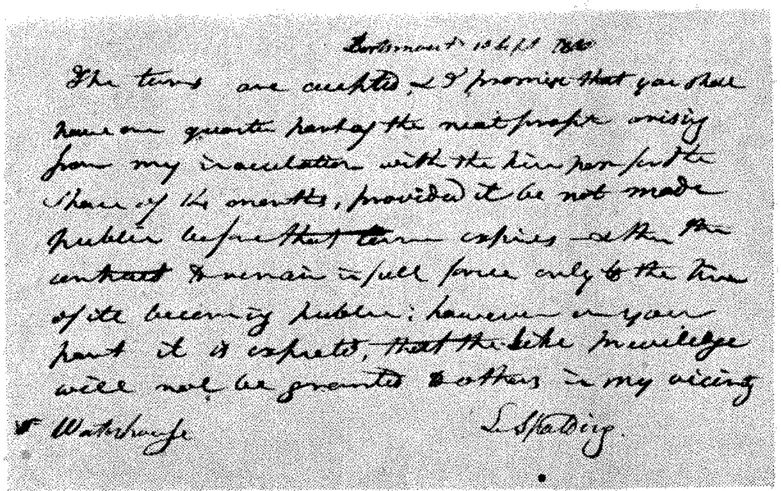
Dr. Waterhouse"

Additional Material of J. A. Spalding

James Alfred Spalding was the grandson of Lyman Spalding. He was born in 1842. In 1908 he was given Lyman Spalding's papers to look over, and this biography[14] was published in 1916. This book is very little known and there is probably only one copy in the libraries of London. It is not in the British Museum.

Since the biographer had all the papers, he was able to give much additional information on this interesting subject. The correspondence opened on August 25, 1800, when Spalding heard that Waterhouse had vaccinated his household successfully, and he asked for a supply of lymph. Waterhouse replied on September 6, 1800, advising Spalding not to vaccinate in a smallpox hospital. It is not clear whether Spalding had meanwhile written again ; but, though there is confusion of dates, this must be the case. Waterhouse then wrote the letter which is reproduced here as letter (*a*). J. A. Spalding says that Lyman's reply had not been preserved ; but that there was a copy of it. This must be letter (*b*). It is apparently written and signed by Lyman Spalding, and bears th name of Waterhouse on the revers —as if it had been given to som friend to deliver.

The Dr. Cutter mentioned in letter (*a*) may have been either th father or the son—both being well known physicians at Portsmouth "Sam B." was Sam Brown, who had been a friend of Lyman Spaldin



Portsmouth 10 Sept 1800

The terms are accepted, & I promise that you shall have one quarter part of the neat profit arising from my inoculation with the kine pox for the space of 14 months, provided it be not made public before that term expires—& then the contract to remain in full force only to the time of its becoming public: however on your part it is expected, that the like priviledge will not be granted to others in my vicinity

Dr Waterhouse

L Spalding

(*b*) Letter from Spalding to Waterhouse
Original in the Wellcome Historical Medical Museum (39826·2)

at Harvard. Lyman Spalding was the youngest physician in the town, and Waterhouse was evidently disinclined to give his cowpox matter to him alone, to the exclusion of an older physician.

Sam Brown had been following up the patients vaccinated by Waterhouse, to see whether the scabs could not be used to vaccinate his own patients. In his next letter—September 12—Waterhouse says that the time factor proposed is too vague, as Sam Brown may steal the method within a month. He therefore proposed that the term should be for twelve months. "You, however, will have *got the start of all the others*, so much that no one can rival you entirely; besides it will fix you in business. My fee is Five Dollars." Each man stuck to his guns—Spalding for monopoly, Waterhouse for Cutter and a higher figure. On September 18, Waterhouse informed Spalding that he had divided New Hampshire into three vaccination districts, with the exception of certain specified towns.

At this time the method was generally in use of transmitting the vaccine matter on pieces of linen thread, and it was for one of these threads that the bargaining was taking place. From a bond which existed when the book was written, it would appear that Waterhouse sometimes let one of these go for 150 dollars. On September 25, however, Waterhouse did send Spalding a thread; but he did so under protest that older men should have been included in partnership, and declared that he hoped that Lyman would take them in with him, so that vaccination could be extended everywhere as rapidly as possible. Spalding acted at once on receipt of the thread, and in one day vaccinated thirty persons. Shortly after this it was found that the virus could be passed from arm to arm, and linen threads and bonds immediately became valueless.

The two letters reproduced here in facsimile were presented to the Wellcome Historical Museum by Sir William Osler on January 31, 1919, eleven months before his death. In the note accompanying the two documents, Osler said that from them it would be seen that "they tried to make it a commercial affair; this I did not know". Item 6814 in the "Bibliotheca Osleriana"—the printed catalogue of Osler's library—is this biography by J. A. Spalding, and it seems strange that Osler had not at least glanced at it.

The manner in which these two letters came into Osler's hands is unknown. One can only assume that these two items were given to someone from the Spalding collection. If they had been given to Osler direct by the owner of that collection, Osler would have known a lot about the subject. Further, if the Spalding collection had been broken up, he would almost certainly have heard the fact. Would he not also have picked up many more letters, for was he not "William the Fowler, Guillaume l'Oiseleur", who kept all that was taken in his net ?[17]. It would be of interest to know what has happened to the Spalding letters as a whole.

On March 4, 1801, Jenner wrote his first letter to Waterhouse. It is a long letter full of sound advice, and is published by Waterhouse in full in the second part of his "Prospect". In 1802 Waterhouse was for a time forced to hire volunteers in Cambridge to keep up the strain of fresh virus. The correspondence with Jenner continued. This second part of the "Prospect" was criticized by the Massachusetts Medical Society as being obscure and not worth looking at. But he was much helped by British friends, and the book sold fairly well in the South. Meanwhile, vaccination was spreading to other parts of the United States, and this is too large a subject to deal with here.

A Third Letter in the Wellcome Collection

This is half of a four-page letter on foolscap. It has not, so far as I know, been published previously. The text is as follows:

(c) Waterhouse to an unknown correspondent (W.H.M.M. (95443)):

". . . I have just finished reading the different state papers relative to the armed neutrality. Partial as I am to Old England, I must confess that I think these northern nations have truth, and reason on their side. I do not see at present what arguments Great Britain can bring to bear against them, unless it be the *ultima ratio regum*, and that may not be a conclusive one, while this confederacy is so strong, aided as it is, by so potent a monarch as that of Prussia. France will doubtless try to bring us into this combination, and probably will expect to accomplish her views under *Jefferson*, which she would have despaired of under *Adams*. She will nevertheless fail in her expectations. The merchantile interest has great weight in these States, and our Executive cannot bend it to its wishes.

"Jefferson is a prudent man. He sets out with conciliating parties. He says 'we are all federalists, all republicans', and has delivered *sentiments* universally approved & admired. His speech is doubtless in London before this time. As a fine composition the man of taste will read it with pleasure. Jefferson is besides a man of mild & pleasing manners, naturally disposed to complaisancy, whereas Adams was a perfect *John Bull*, and accompanied his honesty with a roughness that in some cases narrowed his way to usefulness. You will find President Jefferson's speech in one of the papers in the box containing the cheese.

"I have just written to our Medical Society to ask their advice respecting the best method of diffusing the vaccine matter through our Land. I have also proposed to them a plan for a *Vaccine Institution* for inoculating the poor gratis. I wish I could obtain a copy of the rules, directions &c &c of the Vaccine Institution in London. Had I thought of it earlier, I would have requested a copy of it from Dr. Pearson.

"I am sorry, very sorry to hear that Jenner & Woodville even glance in their respective works at anything like personalities. We have honored & esteemed these celebrated men for their beneficent productions, and shall lament if in place of affording us more good & wholesome fruit, they should produce thorns. For more than a year I have held up these two eminent physicians to the *American public*, as men who could scarcely err. On that account I feel doubly mortified, that two, out of the three oracles which I have constantly appealed to, should clash in opinion. We feel interested in those we admire.

"I think I have already said that the matter which was on thread between two plates of glass, envelloped in a note to you signed '*Jno. Cn. Wachsel*', produced the disease to *perfection* in every patient I inoculated with it.

"I propose to write again in about a month by a Mr. Nancrede, one of our first booksellers. Till then adieu! and remember that I am your affectionate friend

B. Waterhouse"

April 14th, 1801

In this letter the direct comparison of Jefferson with Adams is interesting. Waterhouse had had contacts with both these presidents of the United States. When he was at Leyden, John Adams was sent by Congress to Holland to court an alliance, but he was forced to remain a year before he was publicly recognized as the American minister. During this time Adams, his two sons, his secretary, and Waterhouse formed one family[9]. Twenty years later he sent Jefferson a copy of his pamphlet on cow-pox—that is, the first part of his "Prospect"—and on December 25, 1800, the President sent him a very cordial letter of thanks, which Waterhouse published in his second part[11]. Six months later Waterhouse wrote a long letter to Jefferson, giving instructions how to perform vaccination, enclosing infected thread and books and drawings. In this letter he also suggested that the President should arrange for an experiment to be made by "some cautious discerning person, perhaps his own family physician. A series of experiments may be directly instituted by him." Three unsuccessful attempts were made to vaccinate the President's family with three separate batches of "virus". A fourth attempt was successful. The President was attentive to all applications made to him for cowpox matter, and he it was who was thus responsible for introducing vaccination into the District of Columbia, Pennsylvania, Maryland and Virginia.

The reference to Woodville recalls the fact that he was one of the first in London—after Cline—to practise vaccination. But he performed the operation in the Smallpox Hospital, and three days after vaccinating he inoculated the patients with smallpox matter. The result was that the "cowpox matter" from the pustule was really a combination of cowpox matter and smallpox matter. This material, distributed far and wide, caused many smallpox rashes. Jenner had considerable difficulty in saving the situation.

The great esteem in which Waterhouse held Jenner is seen in this letter, and is even more fully expressed in the second part of his "Prospect"[19].

Back to Jenner

If much of this article has been devoted to persons other than Jenner he would not have minded—even on his birthday. In the mass of correspondence which has been preserved, dating from the time of publication of the "Inquiry", we get a very good picture of the man. During the early stages of the movement to promote vaccination he was the oracle to whom everyone turned for guidance, and loaded with honours as he was, he never lost his head. Even his erroneous views—and that there must have been erroneous views at that period when immunology was still unborn is obvious—were often blessings which kept some semblance of correctness when some men tended to stray into dangerous by-ways.

Jenner became almost at once a national hero, and his name was nearly as well known abroad as it was in his own country. His vast correspondence led him to term himself "the vaccine clerk of the whole world". His private practice certainly suffered, and in 1802 Parliament made him a grant of £10,000. In 1806 he was voted a further £20,000. To the end he worked unceasingly for the cause of vaccination. On January 26, 1823, he passed peacefully to his rest.

Jenner never cared very much for the high honours which he received; but he did care a great deal for the practice which he had discovered and helped to foster. That is why he would have perhaps preferred an article on the movement to a eulogy of the man.

[1] Baron, J., "Life of Edward Jenner", 1, 33 (1838).

[2] Jenner, E., *Phil. Trans.*, 78, Pt. ii, 219–237 (1788).

[3] Baron, *op. cit.*, (1), 1, 121.

[4] Underwood, E. A., presidential address to the Hist. Sect., Roy. Soc. Med. (1949).

[5] Baron, *op. cit.* (1), 1, 334–39.

[6] *idem.*, *ibid.*, 392.

[7] *idem.*, *ibid.*, 359.

[8] *idem.*, *ibid.*, 155.

[9] Welch, W. H., "The Jenner of America", *Proc. Philadelph. Co. Med. Soc.* (1885).

[10] Waterhouse, B., "A Prospect of Exterminating the Small-Pox" (Boston, 1800).

[11] *idem.*, *ibid.*, Part ii (Cambridge, Mass., 1802).

[12] Baron, *op. cit.*, (1), 1, 386, and Waterhouse, *op. cit.* (10).

[13] *idem.*, *ibid.*, 439–43.

[14] Spalding, J. A., "Dr. Lyman Spalding" (Boston, 1916).

[15] Leikind, M. C., *Bull. Hist. Med.*, 7, 671–86 (1939).

[16] Appleton's "Cyclopædia of American Biography", 5 (1888–89).

[17] Kelly, H. A., and Burrage, W. L., "Dict. of Amer. Med. Biography" (1928).

[18] See sonnet by Basil Lanneau Gildersleeve in H. Cushing's "Life of Osler", 1, 671.

[19] For other Waterhouse letters, see especially:
Halsey, R. H., "How the President, Thomas Jefferson, and Doctor Benjamin Waterhouse established vaccination as a public health procedure" (New York, 1936).
Fitz, R., *Bull. Hist. Med.*, 11, 239–264 (1942).
Spalding, R. W., *Bull. Hist. Med.*, 20, 69–75 (1946).
Trent, J. C., *J. Hist. Med.*, 1, 25–40 (1946); and *ibid.*, 1, 357–364 (1946).

INDUSTRIAL RESEARCH AND MANAGEMENT

A WEEK-END conference of industrial research directors and managers was held at Ashorne Hill, near Leamington Spa, during March 11–14. It was organised by the Industrial Research Committee of the Federation of British Industries, under the chairmanship of Sir Wallace Akers. The proceedings of the conference were divided into five sessions, at each of which two papers were read. Except for the first session, at which spoken contributions to the papers were made from the body of the hall, the arrangements for discussion were unusual. Immediately after the reading of the papers, the company was divided into six groups which repaired to separate rooms, where each group appointed a chairman to guide about an hour's discussion. Afterwards, the conference re-assembled and the six chairmen reported. Sometimes the groups were given specific questions to try to answer, at others their discussion was unrestricted. In either case, the method appeared to be remarkably successful in promoting full discussion of the papers in the short time available.

At the first session papers were read on the relationship between the research department and the management and other departments of an industrial organisation. Mr. F. H. Saniter described the origin and development of the United Steel Companies' Research and Development Department. It is recognized, Mr. Saniter said, that the amount of new knowledge created by an industrial research establishment is small in relation to the new knowledge continually becoming available from all sources. The Research and Development Department is therefore regarded as having three main functions: collection and dissemination of information, creation of new knowledge by research, and application of knowledge, from whatever source, to practice. The effective functioning of such a department depends on its proper integration into the general structure of the company. At the United Steel Companies this is achieved by a series of committees ranging from a top-level committee, under the chairmanship of the managing director, downwards. These committees are considered primarily as a means of bringing people together periodically to discuss the technical needs of the firm and the ways in which they can be met by the Research and Development Department.

Dr. W. D. Scott (Monsanto Chemicals, Ltd.) gave the second paper in this session, and widened the scope of the discussion to embrace the influence of the research mind throughout the entire industrial organisation. He pointed out that there are three prime executive functions to be performed: to produce, to sell and to plan. The planning function is the intimate concern of the research department, the relationship of which to the management can be established through a number of different types of internal organisation which were illustrated by charts. Throughout, the emphasis was on a proper appraisal of the financial implications of the activities of the research department, particularly in the selection and continuation of research projects.

"Finance, Costing, Laboratory Administration and Scientific Staff, Research Programmes and their Formulation" was the comprehensive subject-heading of the second session, and both the papers and discussion which followed were of necessity selective. Mr. A. W. Montgomery (Standard Telephones and Cables, Ltd.) dealt mainly with human relationships in the research laboratory. Every establishment needs rules, however few, and since research scientists are usually knowledgeable and intelligent people, the rules of a research organisation must be reasonable and arguable. Provision must be made for staff training after engagement, and the need for adding wisdom to knowledge was emphasized. The difficult question of special treatment given to any particular member of a laboratory was touched upon, also the problem of how to treat fairly and employ correctly the older scientific worker of considerable experience who, although he has kept his knowledge up to date, has to some extent, of necessity, lost his original fire and enthusiasm. In one laboratory in the United States, such people are transferred to a group of consultants who are free of access to any individual in the company. In other places their experience is often used successfully in other parts of the company.

Another problem of great difficulty is to decide when a piece of work is complete. It is necessary to stop the work at suitable stages and consider how much can be applied, since it is through the application of research results that the upkeep of the laboratories is ultimately paid for.

Dr. I. J. Faulkner (I.C.I.), dealing with the organisation of research in the chemical industry, emphasized the necessity of not overburdening the research staff with administrative duties. It is also desirable that no individual should have to look after too many others; between four and six was considered to be the maximum. Such small teams can be easily handled, and all have a reasonably rapid approach to their chief.

A special type of organisation is required where research is carried out on a factory-scale. At the I.C.I. works at Billingham, semi-technical and pilot plant involve several hundred pay-roll employees, as well as design, construction and maintenance engineers. This is all brought under the 'research works manager', who takes off the research staff the heavy task of administering this kind of large-scale research activity. He is directly responsible, along with four other assistant research managers concerned with smaller scale research, to the research director.

The distinction between the research budget, the programme expenditure and the costing of research was also discussed by Dr. Faulkner. There are difficult decisions involved in the detailed costing of research, the allocation of costs and the definition of 'overheads', as well as in answering the all-important question, "How much should be spent on research?"

The third session, on the "Application of Research to Production", was opened with a paper from Dr. J. Park (British Oxygen Co.). Industry, and in particular the production man, the salesman and the accountant, live by what is being made now, and they inevitably acquire a vested interest in the present. The research man is concerned with what is coming next and is less interested in existing processes. The research department must win confidence at an early stage and prove that it is more than a 'frill' paid for by the profits of the other departments. It must remember that no new product is industrially significant unless somebody can find a use for it. A modest contribution to the company's present business may win more respect than a successful piece of fundamental work. Finally, the results of research must be effectively 'sold', the proper sales instrument being the concise and clearly worded research report.

Mr. L. J. Davies (B.T.H., Ltd.) classified industrial researches into five groups: (1) ancillary researches (instrumentation, measurement, etc.); (2) materials research; (3) process research; (4) design research; and (5) device research or invention. The difficulties, both technical and personal, which have to be overcome in the course of introducing new methods were illustrated by two examples taken from the electrical industry.

In the fourth session, on "Information and Intelligence, Publications and Publicity", Mr. O. W. Humphreys (General Electric Co., Ltd.) touched upon a topic which was much in evidence in the informal discussions throughout the conference, namely, the form and style of scientific reports. He said that the scientific paper enjoyable for style as well as subject-matter is all too rare; and he thinks that lectures on the English language should be included in all science and engineering courses. Any necessary reduction in the standard of the first degree would be worth it in return for some attention to the humanities.

Dr. C. G. Williams (Shell Petroleum Co.) spoke on the problem of keeping in adequate touch with the ever-rising output of technical literature. As much as can be assimilated in one to two hours a day of general technical reading was thought to be sufficient without too much interference with practical work or risk of mental indigestion. The habit of abstracting is valuable, but classification presents problems; there does not seem to be general acceptance of the Universal Decimal Classification.

The importance of presenting the results of research was emphasized by means of a formula:

$$\text{value of a research} = \begin{array}{c}\text{worth-whileness}\\ \text{of objective}\end{array} \times \begin{array}{c}\text{efficiency of}\\ \text{presentation}\end{array} \times \begin{array}{c}\text{effectiveness of}\\ \text{reporting.}\end{array}$$

If any one of these three factors is zero, the result is zero.

Dr. L. B. Pfeil, in the first paper of the fifth session, described the relationships between the Mond Nickel

Co.'s Research and Development Department and the research associations, universities and Government departments. He made a strong plea for the expansion of Government research activities by enlargement of such establishments as the National Physical Laboratory. There is a great lack of fundamental data now badly needed by industry. Germany was, before the War, a substantial contributor to the pool of fundamental knowledge, but this source has dried up. The work of the N.P.L. and similar establishments is valuable, but much more is needed.

The universities should not generally be used as consultants by industry, but should concentrate rather on the task of providing men of sound character and personality who can think honestly and convey their thoughts with facility to others. Government grants to students and research workers are more helpful in this direction.

Mr. R. M. Winter (I.C.I. Ltd.) urged that fundamental research at the universities should not be swamped by purely tutorial duties. The training of first-class research workers is of more importance that a large output of technicians trained mainly in manipulative skills and laboratory methods. The present urgent requirements for scientific man-power should not be allowed to lower the standards of training of fundamental scientific workers. The Government's spending of £69 millions in 1947–48 on research and development, of which recurrent grants to universities and similar institutions accounts for only £3½ millions, invites comment, Mr. Winter said.

The discussions which followed each of the five sessions were so varied and often lively as to make them difficult to summarize. There appeared, however, to be a general concern over both the quantity and quality of new recruits to the industrial research laboratories. The problem of quantity is largely a result of heavy demand coupled with interruptions to the normal flow of graduates from the universities caused by the War and by the subsequent arrangements for military service. On the side of quality, there was a strong feeling that scientific education should be on broader and less specialized lines, particularly up to the first degree.

As regards the conference as a whole, there was a general impression that it had provided an excellent opportunity for the airing and discussion, between research executives in different industries, of many common problems and interests.

W. C. F. Hessenberg

OBITUARY

Dr. G. Shearer

George Shearer died on March 13 in Addenbrookes Hospital, Cambridge, on the eve of his fifty-ninth birthday.

Shearer entered the University of Edinburgh from George Watson's College in 1907, having taken high places in both the John Welsh Classical and Mathematical Bursaries lists: for his first session he read Latin and Greek, and graduated as M.A. and B.Sc. in 1912 in mathematics and natural philosophy. He remained at Edinburgh as an assistant in natural philosophy until the outbreak of the First World War, and during this period published his first papers, on atmospheric electric potential, and Fourier and periodogram analysis, in collaboration with Dr. G. A. Carse; during this period, too, he began, under Barkla, his X-ray work, which was to be the main subject of his scientific work for the next quarter of a century. As an instructor lieutenant in the Royal Navy during 1914–19 he served afloat on navigational and gunnery duties.

On his release from war service, Shearer resumed his X-ray researches, going to Emmanuel College, Cambridge, as an 1851 Exhibition research student, and working at the Cavendish Laboratory under Rutherford. In 1922 he moved to London, as chief research assistant to Sir William Bragg, first at University College and, from 1923, at the Davy Faraday Laboratory, Royal Institution. During this period he was particularly interested in the newly discovered technique of X-ray photography of powders, and developed the application of this method to the study of the geometry and the symmetry, both of the crystalline arrangement and of the molecules themselves; one of his outstanding achievements was the X-ray chemical analysis and identification of long-chain ketones.

In 1927 Shearer was appointed to the National Physical Laboratory as a senior assistant to take charge of the work for the Committee on the Application of X-ray Methods to Industrial Problems. The group under his charge developed and used both X-ray and electron diffraction techniques, and devised various special items of equipment, such as a rotating anode tube. The problems tackled included the structure of many industrial materials (special steels, paint materials, carbon blacks, insulating materials, etc.) and the basic properties of metals. On the outbreak of the Second World War, he was transferred to the Metrology Division for work on gauges for war production. In 1941 he was seconded, and in 1948 was posted, to the Research Department (now the Armament Research Establishment) of the Ministry of Supply, in which he served until his death; in this last appointment he returned to Cambridge in charge of an out-station, and in 1947 his promotion to senior principal scientific officer enlarged his responsibilities to include the charge of other out-stations. The group of which he was the inspiration was studying the penetration of armour by projectiles, and their work contributed largely to the effectiveness of the British anti-tank artillery and aircraft cannon. Shearer's encouragement and guidance greatly facilitated the application to ballistic problems of such techniques as 'Arditron' flash photography and Kerr cell shutters.

Shearer was granted the degree of Ph.D. at Cambridge in 1921 and D.Sc. at Edinburgh in 1923 for his X-ray work. He was a fellow of the Institute of Physics and of the Physical Society, and a member and past president of the British Institute of Radiology. He also served as a member and chairman of the Committee of Visitors, and as a member of the Committee of Managers, of the Royal Institution.

On his return to Cambridge in 1941, Shearer again had rooms in his old College, Emmanuel. This was a great joy to him, although the arduous nature of his duties left him little leisure for his favourite recreations, bridge and golf, at both of which he was no mean performer. During these years he made a real contribution to the social life of the High Table and the Parlour of the College, and his wide interests and broad sympathies made him a gracious host to many official visitors. An able physicist, a wise administrator, and a modest man, he will be missed by many friends.

NEWS and VIEWS

Biochemistry at Cambridge : Prof. A. C. Chibnall, F.R.S.

PROF. A. C. CHIBNALL, whose impending retirement from the Sir William Dunn chair of biochemistry has recently been announced, has held his present position since 1943. During his period of tenure, the Department of Biochemistry at Cambridge has fully maintained its former distinguished record. Under his guidance there have not only been developments in the major themes of research on the dynamic aspects of biochemistry for which the Department became famous under the late Sir Frederick Gowland Hopkins ; in addition, much more attention has been paid than in the past to the biochemistry of proteins, a subject in which Prof. Chibnall himself is especially interested. As might be expected also, plant biochemistry at Cambridge has received much encouragement at his hands. A notable development which has occurred under Prof. Chibnall is the expansion of work on microbiological chemistry ; this has led to the recognition of microbiological chemistry in the Natural Sciences Tripos, and to the establishment of a major division of the Department, headed first by the late Dr. Marjory Stephenson and now by Dr. E. F. Gale, with responsibility for research and the training of students in this branch of biochemistry. Although Prof. Chibnall's tenure of the chair at Cambridge has been short, he has thus very definitely left his mark on the Department. The regret of his scientific colleagues at his early retirement will be tempered by their knowledge of his intention to remain in Cambridge and to devote to scientific research the time liberated by relief from duties of administration and teaching. Doubtless also his wide knowledge and experience will continue to be available to such bodies as the Agricultural Research Council, to which he has given so much help in the past.

Prof. F. G. Young, F.R.S.

PROF. CHIBNALL will be succeeded in October next by Prof. F. G. Young, who will thus be leaving University College, London, after having held the chair of biochemistry there since 1945. During the War the Biochemical Department of University College was evacuated from London, and one of his main tasks on appointment in 1945 was to superintend its return and to adapt it to post-war needs. This he has done with conspicuous success. Not only have the laboratories been more or less completely re-equipped, but also the teaching provided has been brought up to date by the introduction of a new course leading to the degree of M.Sc. in biochemistry. Prof. Young's research interests are in the sphere of carbohydrate metabolism, and brief mention of his activities to 1945 was made in a previous note (*Nature*, 156, 471 ; 1945). His outstanding achievement has been the production of permanent experimental diabetes in animals by injection of anterior pituitary extracts, and he has subjected the whole question of pituitary control of the insulin-secreting function of the pancreas to close and skilful experimental analysis. The value of his work was recognized recently by his election to the fellowship of the Royal Society. Under Prof. Young's vigorous leadership, the Biochemical Department at University College has become once again a flourishing centre for teaching and research, and his pending departure will be viewed by his colleagues there with great regret. He goes to Cambridge with an established reputation, and he carries with him the good wishes of his numerous friends at home and abroad.

Specialization at Universities

THE numbers of university undergraduates, in the technical faculties especially, are to-day greater than ever before, and yet apprehension as to the true worth of university training was never so widespread as at the present time ; for modern scholarship has made such strides, particularly in the field of science, that no one subject can be adequately studied without undue specialization and consequent neglect of other points of view. This danger of specialization was the theme of Mr. Oliver Stanley's recent address, on being installed as chancellor of the University of Liverpool, when he said that too many men and women to-day leave a university complete masters of a subject but still incomplete individuals, unable to act as evangelists of that broader culture, that more general philosophy which should be the university's gift to the people. These words were echoed by Mr. Winston Churchill when, on the same occasion, he received the honorary degree of doctor of laws. Indeed, Mr. Churchill went further and, to a certain extent, accused science of being the usurper of culture. Few men of science would seriously dispute that ". . . We need a lot of engineers but we do not need a world of modern engineers. . . . Science must be the servant and never the master of mankind" ; but Mr. Churchill's further statement, "I would venture to say that no amount of technical knowledge can replace the value of the humanities or the study of history", is one that is open to challenge. The study of science need not preclude a deep appreciation of the humanities ; rather it is the high degree of specialization within the syllabus which is the excuse for not teaching a general appreciation of scientific principles. Many physics graduates have very little knowledge of the processes of life, just as, say, the majority of botanists are probably unaware of even the elementary facts of the quantum theory or relativity ; and both know very little of either the history or philosophy of science. It is on this last point that, no doubt, science is lacking as a medium for educating (in the widest sense of the word) the student. If the teaching of science itself were less specialized and more cultural, then perhaps a scientific course would be more readily recognized as being as good an education as, say, a classical one, for training the undergraduate to become a leader of thought and action.

New Coalfield in Britain

IT has been announced by the Lord President of the Council that a new coalfield has been discovered in south Staffordshire during the course of deep boring by the Geological Survey of Great Britain. At a minimum estimate this coalfield contains 400 million tons of workable coal, and the amount may possibly be several times as great as this estimate. The seams lie at a depth of about 3,000 ft. ; thirty feet of coal has so far been discovered, including seams of 8, 6 and 5 ft. Boring is still going on, and it is likely that further seams will be found. The boring is at Whittington Heath near Lichfield. The new coalfield is situated between the Cannock Chase coalfield and the Warwickshire coalfield, in both of which the productive coal measures crop out at surface. Additional borings will be necessary to prove the full resources and detailed structure of the new field. Funds to undertake a programme of deep boring were granted to the Geological Survey in 1947 for the purpose of investigating the deep-seated geological structure of Great Britain. It is unlikely that all the bores will give direct economic results of such importance as the Lichfield bore; but the information gained from the bores will enable geologists to interpret the structure of the rocks at great depths beneath considerable areas of the country. Knowledge of this kind is of great general importance in the search for underground mineral and water resources. Mr. T. Eastwood, assistant director of the Geological Survey in charge of mineral deposits of England and Wales, is responsible for the work. Boring has been carried out by the Craelius Company under contract.

Universities of the British Commonwealth: Congress in Canada

A MEETING of representative vice-chancellors and principals of the various countries of the British Commonwealth is to be held in Canada next month. At the Congress of Universities of the Commonwealth held at Oxford in July 1948, it was decided that there should be smaller meetings of executive heads of universities annually in some part of the Commonwealth in order to discuss matters of common policy, including the implementation of the decisions of the Congress on inter-university relationships (interchange of staff, students, etc.). This, the first of such conferences, will take the form of a meeting of the Executive Council of the Association of Universities of the British Commonwealth, and will be held at Halifax, Nova Scotia, during June 10–11, followed by the annual meeting of the National Conference of Canadian Universities during June 12–15, at which the overseas representatives will be guests. The conference will conclude with a meeting in Montreal on June 17. The president of McGill University, Dr. F. Cyril James, will preside, and the local arrangements are in the hands of Mr. T. H. Matthews, registrar of McGill University and secretary–treasurer of the National Conference of Canadian Universities.

The following is a list of delegates who will be attending the Conference. *Great Britain and Ireland:* Sir David Lindsay Keir (vice-chancellor, Queen's University, Belfast), Very Rev. Dr. J. Lowe (vice-chancellor, University of Oxford) and Prof. Lillian Penson (vice-chancellor, University of London). *Canada* (representatives on Executive Council): Dr. F. Cyril James (principal, McGill University, Montreal), Monseigneur F. Vandry (rector, Laval University, Quebec) and Dr. R. C. Wallace (principal, Queen's University, Kingston, Ontario). *Australia:* Prof. D. B. Copland (vice-chancellor, Australian National University) and Prof. W. Prest (dean of the Faculty of Commerce, University of Melbourne). *South Africa:* Dr. E. G. Malherbe (principal, University of Natal) and Dr. H. R. Raikes (vice-chancellor, University of the Witwatersrand). *New Zealand:* Dr. R. S. Aitken (vice-chancellor, University of Otago). *India and Ceylon:* Dr. P. N. Banerjee (vice-chancellor, University of Calcutta) and Sir A. Lakshmanaswami Mudaliar (vice-chancellor, University of Madras). *Pakistan:* Dr. S. M. Hossain (vice-chancellor, University of Dacca). *Other parts of the Commonwealth:* Colonel Lindsay Ride (vice-chancellor, University of Hong Kong). *Officers o the Association:* Sir William Hamilton Fyfe (honorary treasurer, formerly vice-chancellor, Queen's University, Kingston, Ontario, and University o Aberdeen), Mr. J. F. Foster (secretary of the Association and of the Committee of Vice-Chancellors and Principals of Great Britain and Ireland, formerly registrar of the University of Melbourne, Australia and Miss Margaret Palstra.

Petroleum Oils and the Fruit-grower

A LECTURE given by Dr. T. Swarbrick to the Roya Society of Arts, on January 26, described, *inter alia* some interesting features of the use of petroleum oils for controlling the pests of fruit trees. One difficulty about their use was an occasional phytotoxic effect. The chemists of the Royal Dutch-Shel Group have now traced the cause of this damage and found methods for its removal. Earlier work by Chapman and Pearce indicated the necessary conditions of boiling point and viscosity which conferred insecticidal action. Petroleum can also be used as a total or selective weed-killer, and new methods of application are designed to reduce the amount of water required in spraying. Atomized oil sprays may need no more than 2¼ gallons of spray fluid per acre for crops of small fruit.

A Virus-inhibiting Protein

A GLYCOPROTEIN which can inhibit the activity of tobacco mosaic, tomato bushy stunt and other plant viruses has been isolated by B. Kassanis and A. Kleczkowski (*J. Gen. Microbiol.*, 2, No. 2; May 1948). It was obtained from the sap of *Phytolacca esculenta* by differential precipitation with ethanol followed by adsorption on 'Celite' and elution with 10 per cent sodium chloride. The protein is unaffected by pepsin and trypsin unless it is denatured, and it is not effective against bacteriophage.

Royal Institute of Chemistry

AT the annual general meeting of the Royal Institute of Chemistry held on April 28, it was announced that H.M. the King had been graciously pleased to grant to the Institute on April 14 a new royal charter in substitution for the original charter of 1885 and the supplemental charter of 1944. In the new charter it is made clear that the Institute is concerned with the whole profession of chemistry and not merely with that of "analytical and consulting chemistry", as stated in the original charter. The powers of the Institute have been modified in certain respects so as to facilitate the progressive development of its activities and services in the interests of the profession and of the public. The title of the Institute has been changed from "The Royal Institute of Chemistry of Great Britain and Ireland" to "The Royal Institute of Chemistry". It has been resolved to amend the by-laws so as to provide that citizens of Eire, as well as British subjects, shall be eligible for admission as members or for registration as students of the Institute. Resolutions were passed at the meeting authorizing the Council to establish, as a benevolent fund, a Residential Clubs Fund.

The following officers for 1949 were elected: *President*, Prof. J. W. Cook; *Vice-Presidents*, Prof. F. Challenger, Mr. H. Krall, Prof. R. P. Linstead, Mr. G. Roche Lynch, Mr. J. A. Oriel, Mr. E. T. Osborne; *Honorary Treasurer*, Dr. D. W. Kent-Jones.

Physical Society: Summer Meeting at Cambridge

The summer meeting of the Physical Society will be held this year in Cambridge during July 14–16. The main subject will be "The Ionosphere and the Propagation of Radio Waves". Among the speakers will be Prof. S. Chapman (Queen's College, Oxford), Mr. J. A. Ratcliffe (Cavendish Laboratory, Cambridge), Dr. A. C. B. Lovell (University of Manchester), Mr. G. Millington and Mr. S. B. Smith (Marconi Wireless Telegraph Co.), and representatives from the Radio Research Board and the British Broadcasting Corporation; visitors from France, Norway and Sweden are also expected. Attendance at the Conference is free to all members of the Physical Society; a fee of 10*s*. a day will be charged to non-members. Further details may be obtained from the offices of the Physical Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7. Non-members of the Society should apply by May 31.

Geological Society of London: Officers for 1949

At the annual general meeting on April 27 of the Geological Society of London, the following officers and members of the Council were elected for the coming year: *President*, Prof. C. E. Tilley; *Vice-Presidents*, Prof. J. A. Douglas, Prof. L. Hawkes, Dr. G. M. Lees and Prof. H. H. Read; *Secretaries*, Dr. D. Williams and Prof. S. E. Hollingworth; *Foreign Secretary*, Prof. O. T. Jones; *Treasurer*, Mr. P. Evans. *Other members of Council*: Dr. A. J. Bull, Mr. A. J. Butler, Dr. F. Dixey, Dr. K. C. Dunham, Dr. W. L. F. Nuttall, Dr. K. P. Oakley, Dr. J. Phemister, Prof. W. J. Pugh, Prof. F. W. Shotton, Dr. W. Campbell Smith, Dr. C. J. Stubblefield, Prof. D. M. S. Watson, Dr. E. I. White and Prof. Alan Wood.

University of Sheffield

The Council of the University of Sheffield has made the following appointments: B. R. Dudley, at present research assistant to the Professor of Engineering, to be lecturer in the Department of Mechanical Engineering; and Dr. Hsun Lee, at present independent research worker for the British Iron and Steel Research Association, to be research fellow in the Department of Metallurgy.

The following resignations were announced: Dr. J. A. Pope, senior lecturer in mechanical engineering, on his appointment to the chair of engineering in the University of Nottingham; Dr. J. H. Bowie, lecturer in bacteriology, on his appointment to the post of bacteriologist at the Royal Infirmary, Edinburgh; Dr. A. E. Bender, assistant lecturer in biochemistry, on his appointment as leader of a nutrition research team at the Crookes Laboratories.

The Night Sky in June

Full moon occurs on June 10d. 21h. 45m., U.T., and new moon on June 26d. 10h. 02m. The following conjunctions with the moon take place: June 3d. 04h., Saturn 3° S.; June 13d. 22h., Jupiter 5° N.; June 24d. 15h., Mars 4° S.; June 24d. 18h., Mercury 8° S.; June 27d. 21h., Venus 4° S.; June 30d. 13h., Saturn 2° S. Mercury is in inferior conjunction on June 3 and is stationary on June 15. The planet reaches greatest western elongation on June 28, and at the end of the month rises an hour before the sun. Venus is an evening star, setting about an hour after the sun during June, and can be seen for a short time in the western sky. Mars is a morning star, rising at 3h. 10m., 2h. 40m., and 2h. 12m., at the beginning, middle and end of the month, respectively, and is visible for a short time in the eastern sky. Jupiter is visible in the early morning hours, rising at 23h. 30m., 22h. 33m., and 21h. 30m. on June 1, 15 and 30, respectively. Saturn is visible during the earlier portion of the night, setting at 0h. 40m., 23h. 45m. and 22h. 50m. at the beginning, middle and end of the month, respectively. No occultations of stars occur during June. Summer solstice commences on June 21d. 18h.

Announcements

The Stephen Paget Memorial Lecture of the Research Defence Society will be delivered by Prof. C. Lovatt Evans, on the occasion of the annual general meeting of the Society on June 9; he will speak on "Physiological Research and the Vivisection Act".

Commdr. R. G. A. Jackson, of the Treasury, will examine with, and report to, the secretary of the Department of Scientific and Industrial Research, Sir Ben Lockspeiser, the administrative arrangements by which the Government is promoting the application of scientific knowledge to problems of productivity and economic development. Commdr. Jackson was director-general of the Middle East Supply Centre during the War, and later became an assistant secretary-general of the United Nations.

Mr. E. C. Cherry has been appointed to the Henry Mark Pease readership in telecommunications tenable at the Imperial College of Science and Technology, London, as from October 1.

The seventh International Botanical Congress will be held in Stockholm during July 12–20, 1950. Excursions in connexion with the Congress will start on June 27, and others to follow it will end on August 9. A preliminary programme and excursions can be obtained from the Secretary-General, Dr. Ewert Åberg, Uppsala 7.

The fourth Annual Electronics Exhibition of the North-Western Branch of the Institution of Electronics will be held at the College of Technology, Manchester, during July 19, 2.30 p.m.–9 p.m., and July 20–21, 10 a.m.–9 p.m. There will also be an exhibition of scientific films arranged by the Manchester Scientific Film Society. Admission to the Exhibition will be by ticket only, obtainable from Dr. J. A. Darbyshire, 'Melandra', 1 Kershaw Road, Failsworth, Manchester.

The French Physical Society is holding an Exhibition of scientific instruments and apparatus in the Salons de l'Université, Sorbonne, at 47 Rue des Écoles, Paris 5, during June 4–9. Further information with regard to the Exhibition may be obtained from M. Marandon, 61 Avenue de l'Observatoire, Paris 14. The Society is also holding a meeting on June 4 at which the Holweck Prize will be presented to Prof. L. F. Bates, of the University of Nottingham, who will give a lecture on "Thermal Effects due to Magnetization Processes in Weak Fields".

A summer school in the theory and application of the electron microscope will be held in the Cavendish Laboratory, Cambridge, during August 16–17. The course is intended for those who will be using electron microscopes in the near future, and the techniques of preparing specimens and of operating various microscopes will be practised. Further information can be obtained from Mr. G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Further Studies in Synthetic Polypeptides

OUR investigations of synthetic polypeptides, which have been proceeding concurrently with, although independently of, those described by Astbury and Dalgliesh[1], were also inspired by the announcement of the discovery of a benzene-soluble co-polymer prepared from anhydro-N-carboxy-DL-β-phenylalanine and L-leucine by Woodward and Schramm[2] using the Leuchs polymerization[3].

We would confirm the results of Astbury and Dalgliesh[1] that the majority of the synthetic polypeptides so far prepared give X-ray powder photographs resembling those given by β-proteins. We found, however, that the copolymers (1 : 1 mol.) of DL-β-phenylalanine and L-leucine, as prepared originally by Woodward and Schramm[2], and of DL-β-phenylalanine and α-amino-*iso*butyric acid, give X-ray powder photographs the two principal diffraction rings of which correspond to inter-planar spacings of 5·2 and 11·7 A. Films cast from solutions of these co-polymers in benzene, when examined with the X-ray beam parallel to the film surface, give an oriented diffraction pattern (Fig. 1) which is strikingly similar to those given by α-proteins. Some of these preparations of film are extensible, but stretching, even up to 100 per cent, does not appear to affect the X-ray photograph.

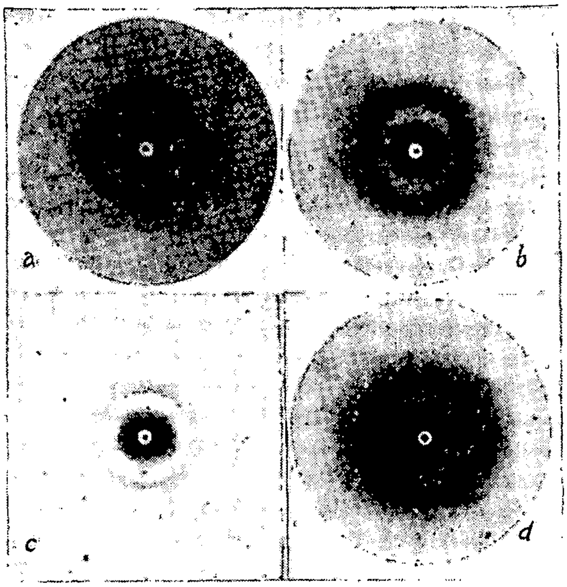


Fig. 1. X-Ray diffraction photographs of synthetic polypeptides: (*a*) film, stretched 50 per cent, with X-ray beam perpendicular; (*b*) film, stretched 50 per cent, with X-ray beam parallel to surface; (*c*) fibres, taut; (*d*) natural α-keratin, human hair, for comparison with (*c*)

In addition, we have now spun fibres of the DL-β-phenylalanine-L-leucine co-polymer. The X-ray photograph of these shows one marked difference from the photograph of the films. While the strongest meridional spacing remains at 5·2 A., the 11·7 A. reflexion becomes oriented on the equator in place of the 10·4 A. reflexion, which disappears altogether from the equator (see Fig. 2).

The similarity of the photograph of the synthetic fibres to that of natural keratin leads to some interesting suggestions regarding their structure. In the first place, we cannot be absolutely certain of the identity of the two photographs; but the spacings are so nearly the same and the general character of the photographs are so similar that we feel them to be produced by essentially the same type of molecular configuration. Up to the present, we have not been able to extend these synthetic fibres into the β-configuration, so complete analogy with natural keratin has not yet been established. The repeat period of the synthetic fibres is 10·4 A., whereas in silk with a fully extended peptide chain it is ~ 7 A., which is in agreement with the length calculated from known bond-lengths and -angles. This fact leads us to suggest that in protein fibres of the α-keratin class, both natural and synthetic, the polypeptide chains do not lie parallel to the length of the fibre, but transverse to it. If this were so, the structure would be held together along the fibre by hydrogen bond systems and by the interlocking of the side-chains (Fig. 3). Experiments are in progress to test the truth of these hypotheses.

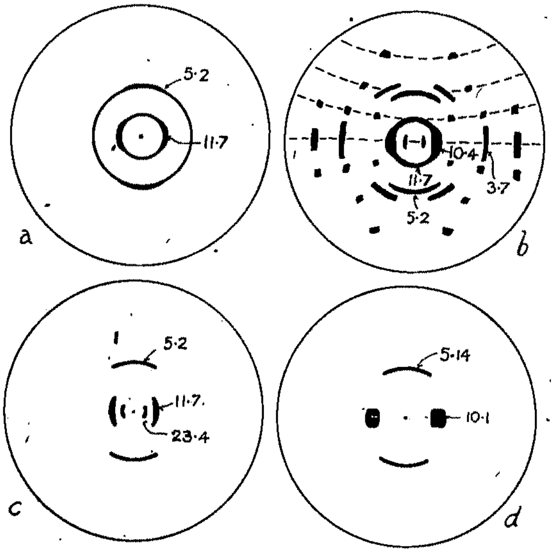


Fig. 2. Inter-planar spacings measured from corresponding photographs in Fig. 1

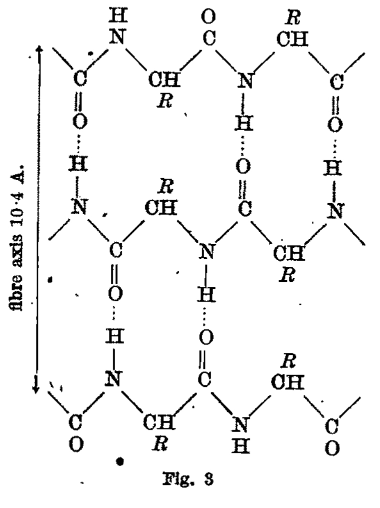


Fig. 3

The molecular weights of the films have been estimated by end-group methods; the nitrogen liberated in a Van Slyke amino-nitrogen apparatus, and the absorption of free carboxyl groups by methylene blue, both point to a figure in the neighbourhood of 15,000, very much lower than the "several million" quoted by Woodward and Schramm[2].

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[1] Astbury, W. T., and Dalgliesh, C. E., *Nature*, 162, 596 (1948).

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Organisms Producing Antibiotics in Tropical Soils

EXCEPT for some experiments by Meredith[1] with Jamaican soils, little information is available on the presence in tropical habitats of antibiotic-producing micro-organisms. Using a technique similar to that of Stokes and Woodward[2], we are finding increasing evidence that tropical soils harbour such organisms, sometimes types which have not yet been identified.

Actinomycetes, as was to be expected, are widely represented, but in our opinion are of much less interest than certain spore-forming and non-spore-forming aerobic bacteria which occur there. These produce a surprisingly selective inhibition of the growth of other organisms.

A short rod, for example, discovered by one of us (I. T.) in Trinidad air, and presumably carried there with soil particles, produces a water-soluble thermostable and apparently non-toxic antibiotic which arrests the growth of all the fungi and yeast tested —so far more than forty species. Its action is often a positive one in concentrations of less than one part in a million. Against Gram-positive and Gram-negative bacteria this antibiotic is inactive.

Another organism which has been isolated is active against fungi, bacteria (*Bact. coli commune*) and aerobic bacilli (*Bact. mycoides*), while others are effective against fungi and bacteria.

In one of the investigations now proceeding the presence of peptone in the culture medium is essential for the production of an antibiotic. In another series glucose and peptone are required. It has not yet been ascertained whether peptone can be replaced by amino-acids, and, if so, by which.

It is proposed to extend the study now in progress to cover tropical habitats other than soils, and to alter the technique employed so that organisms may be collected—if they should exist—which may require materials other than peptone and glucose for antibiotic production.

In his review of bacteria in soil, Conn[3] refers to the isolation of antibiotic organisms from soils. He admits the interest of such work, which he classifies as both important and practical, though not agriculturally significant. We suggest that the existence of organisms producing antibiotics may play a part in maintaining a balanced microflora in soil. In this we are in full agreement with the views of Brian[4] expressed recently.

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April 7.

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Concentration of the Toxic Substance from 'Agenized' Flour

IT was shown by Sir Edward Mellanby[1] that flour, treated with nitrogen trichloride, as it is in the commercial 'Agene' process, is capable of causing fits in dogs, when fed in fairly large quantities. Further investigations have proved that the toxicity is associated with the gluten of the flour, and that the toxicity survives digestion with pepsin and with trypsin[2]. The recent publication in abstract by Reiner *et al.*[3] of particulars of the fractionation and concentration of the toxic substance (mainly prepared by the action of nitrogen trichloride on zein), and the publication by Moran *et al.*[4] of a method of concentration of the toxic substance from zein, make it desirable for us to give our own results.

The process employed involves pancreatic digestion of the gluten followed by passage through resin columns and precipitation with mercury acetate. The gluten was not previously separated from the flour. 70 lb. of flour 'Agenized' at the rate of 125 gm./sack was mixed with 14 gallons distilled water, 500 gm. pancreatin and 500 ml. chloroform. The mixture was adjusted to *p*H 8 with sodium hydroxide and disodium hydrogen phosphate and digested at 37° for 24 hr. The sludge was centrifuged. The recovered gluten was re-suspended in about 3 gallons of water, brought to *p*H 8, and a further 500 gm. pancreatin added. This mixture was digested for a further 48 hr. at 37° and centrifuged. The supernatant from this digestion was usually more toxic than that from the first. It was treated with 2 vol. of absolute alcohol, and the precipitate formed was centrifuged off. The alcoholic liquor was passed through a column containing 2½ lb. of activated 'Zeocarb 215'. When the adsorbed material was eluted with dilute sodium hydroxide, the toxicity was found in the neutral 'fraction' associated with some residual quantities of the acidic and basic amino-acids.

The concentrate so obtained was treated with acid-activated alumina, which removed the acidic amino-acids. After extraction with butanol, a product was obtained which showed four spots on two-dimensional paper chromatography, three of which could be identified as glycine, serine, alanine, and the fourth as glutamine running with an almost indistinguishable unknown substance.

In order to confirm the possibility that this unknown spot was associated with the toxic substance, a quantity of the concentrate was placed in a line along the edge of a large sheet of filter paper and developed with phenol in a direction at right angles to the line. The unknown spot was then located in a long streak parallel to the original position. This part of the chromatogram was eluted with water, and the presence of the toxic substance in it was confirmed by feeding tests.

Later it was found that the unknown spot, which is shown up by the ninhydrin reaction, is accompanied by another, which does not give the ninhydrin reaction, but is detectable in ultra-violet light. As an alternative to the chromatographic separation, which is extremely laborious on a large scale, it was found that the toxic substance could be precipitated by mercuric acetate, added in 25 per cent alcohol solution acidified with acetic acid. The precipitated mercury salt was suspended in water, and hydrogen sulphide was passed to precipitate the mercury. The solution was evaporated to dryness. About 20 mgm. nitrogen of the substance obtained was required to give the toxic symptoms in a ferret. On chromatographic examination it was found that the spot which we believed to be that of the toxic substance was not now accompanied by the fluorescent material. The product has, however, varied somewhat in different preparations, probably owing to an uneven efficiency of the separations, which are not easily controlled. In some cases the two-dimensional chromatogram shows only the one spot; in others, it has been accompanied by others representing histidine, glutamine, asparagine, valine and leucine. Traces of cysteine have also been detected in some preparations. It was later found that in some of the toxic preparations all the chromatographic spots could be accounted for, so that it is likely that the toxic substance, although closely associated with glutamine, does not itself give a ninhydrin colour. This is confirmed by the fact that a similar product from a non-toxic flour also gives the same spots. A further purification on the same scale is being attempted.

We are indebted to Prof. E. C. Dodds for his interest; to Messrs. Wallace and Tiernan for their financial support and permission to publish, and also for assistance with the large-scale digestions, which were carried out in their works; to Dr. D. W. Kent-Jones, for the preparation of the 'Agenized' flours and for constant interest and advice; and to Dr. L. Reiner, of Messrs. Wallace and Tiernan, Newark, New Jersey, for helpful discussions with the senior author during March 1948, in which the methods employed by him at that time were disclosed, and Mrs. S. Simpson for assistance with the toxicity tests.

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Influence of Desoxycorticosterone on Glycogen Formation and Glucose Uptake of Isolated Muscle

Isolated diaphragm muscle of rats produces glycogen from glucose especially in the presence of insulin in oxygenated Ringer's solution. This is inhibited by the addition of small doses of desoxycorticosterone[1]. If the muscle works in response to rhythmic stimulation for two hours, glycogen is newly formed and is broken down again. This is also inhibited by desoxycorticosterone[2]. The action of other steroid hormones was also studied. They had either equal effect (progesterone, testosterone) or none (corticosterone, etc.)[3].

We have now studied whether desoxycorticosterone also inhibits the glucose uptake[4] of the surviving isolated muscle.

The diaphragm of normal rats was cut into three pieces immediately after death. One served for the estimation of the starting value of glycogen content. The two other parts were each put in a vessel with 2 c.c. of Ringer's solution with 200 mgm. glucose and 1 unit of insulin per 100 c.c. The vessels were shaken in an oxygen atmosphere at 37° C. for 90 min. To one vessel 0·1 mgm. desoxycorticosterone was added (5 mgm. per 100 c.c.).

Thirty rat diaphragms were tested, and the results are given in mean values with the median error $(\sqrt{\Delta^2/n(n-1)})$. Besides the glycogen formation, the glucose content of the solution was also measured at the beginning and end of the experiment. The methods used were the same as before[1-3].

Mean values

	Glycogen production (30 experiments)	Glucose uptake	NH_3 produced (13 experiments)
Per 100 gm. muscle in 90 min.	272±37 mgm.	457±24 mgm.	8·0±0·6 mgm.
Same, with *addition of* 4·4, 5 or 7 mgm. per 100 c.c. desoxycorticosterone	56± 5 mgm.	200±20 mgm.	9·0±1·3 mgm.

The surviving muscle about doubled its glycogen content in this period, as in former experiments[1]. It took up glucose from the solution, but considerably more glucose disappeared than corresponds to the newly formed glycogen[4]. This occurred in each single experiment and is shown in the mean value, where 272 mgm. glycogen production compares with 457 mgm. glucose consumption.

Desoxycorticosterone totally inhibited the glycogen production; but it decreased the glucose uptake only to about one half. This value seems to correspond to the difference between the glycogen produced and the total glucose consumption of the muscle without addition of desoxycorticosterone. It might be, therefore, that the remaining glucose is metabolized, and that desoxycorticosterone inhibited only glycogen formation. However, it may also be that primarily the permeability for glucose is decreased, and this accounts for the decrease in glucose uptake and in glycogen formation. We intend to study this problem further.

In thirteen experiments, the ammonia production of the surviving muscle was estimated in the solution, using Conway's method[5]. It seemed possible that after the inhibition of glycogen formation, the muscle increased protein breakdown through desamination. No increase of ammonia production was found.

We thank Ciba A.G. for providing us with desoxycorticosterone.

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Distribution of Ribonucleic Acid in the Cytoplasm of Growing Cells Studied with Phosphorus-32

THE occurrence of ribonucleic acid in the submicroscopic particles obtained by centrifugation of extracts of organs (granules, microsomes, liponucleoprotein complexes) has suggested the hypothesis that these particulate structures might have a role in the synthesis of proteins, and that they may even be identifiable with the viruses and plasmagenes. This idea implies not only that these particles actually exist in the cytoplasm but also that ribonucleic acid is really part of them. It is possible, of course, that they are artefacts which appear upon homogenization of the cells. Indeed, Kleczkowski[1] and Lauffer[2] have shown that a nucleoprotein, the tobacco mosaic virus, is able to form complexes with different proteins under the influence of small changes in the medium, and it is also known that the distribution of ribonucleic acid among the different fractions separable by ultracentrifugation of a tissue extract depends on the salt concentration of the extraction medium[3]. Brachet and Jeener[4] observed in 1943 that high-speed centrifugation of a piece of frog liver displaced a large part of the ribonucleic acid towards the centrifugal ends of the cells; but this phenomenon was not seen when mammalian liver was used. Furthermore, the conditions under which centrifugation is carried out are quite abnormal (using concentrated sugar solutions of the same density as the tissue).

It appeared that the use of labelled atoms might give some idea as to the distribution of the constituents of the granules in the cytoplasm, when the latter is maintained under strictly physiological conditions. Labelled phosphorus was injected into gravid mice, hen's eggs or into pigeons, the crop glands of which were actively proliferating after injections of prolactin. The mouse embryos, chick embryos or crop glands were removed two hours after the injection of the labelled phosphorus and mechanically homogenized with phosphate buffer at *p*H 7·3 containing 30 per cent sucrose. The extract thus obtained was cleared of nuclei and cellular debris by a short centrifugation at low speed and then fractionated by further centrifugation into three parts: (*a*) the 'pellet' of granules obtained after centrifuging for 14 min. at $13 \times 10^3\ g$, (*b*) the pellet resulting from 60 min. centrifugation at $60 \times 10^3\ g$, and (*c*) the supernatant liquid resulting from (*b*). The specific radioactivity of the phosphorus of the ribonucleic acid was determined by the Schmidt–Thannhauser method as modified by Spiegelman and Kamen[5]. In order to get rid of the inorganic labelled phosphate ions an excess of normal phosphate ions was added and the whole eliminated as ammonium magnesium phosphate. A control experiment showed that the ratio between optical density at 255 mμ and the phosphate hydrolysed by 1 *N* hydrochloric acid in three hours at 100° C. was the same in the case of the solution of mononucleotides studied and of a similar solution prepared from purified yeast ribonucleic acid.

As the accompanying table demonstrates, the specific radioactivity of the phosphorus of the ribonucleic acid of each of the three fractions is quite different (there is a probable error of ± 4 per cent). However, it is still impossible to tell to what degree the labelled phosphorus found in the nucleic acid of the different fractions is a measure of the renewal of nucleic acid molecules or of an increase in their number during the growth of the cells.

Specific radioactivity of phosphorus in ribonucleic acid (in arbitrary units per 100 γ P)

	Supernatant of $60 \times 10^3\ g$	Pellet of $60 \times 10^3\ g$	Pellet of $13 \times 10^3\ g$
Mouse embryo	100	16	75
	124	38	82
	605	223	498
	1365	440	1000
Crop gland of pigeon	316	272	475
	5960	143	5170
Chick embryo	155	97	101
	263	45	37

But an important conclusion can be drawn from the facts just stated. It is that nucleic acid is seen to be at least partially associated with particles, and that these really exist in the cytoplasm of the living cell. It would be difficult to explain otherwise how the radioactivity of the phosphorus of the nucleic acid differs from one fraction to another, for such would certainly not be the case if nucleic acid existed in a free state in the cell, associating with other substances to form granules only as a result of the extraction procedure. The results show further that at least three different fractions of ribonucleic acid exist, as well as at least two kinds of granules which contain it.

It may also be pointed out that it seems quite certain that the differences in specific radioactivity which have been observed are definitely present in the living organism and not merely appearing in the extracts during the various procedures, for the turnover of nucleic acid phosphorus in the extracts is three hundred times too small to account for the differences seen.

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The Weiss–Heisenberg Theory of Ferromagnetism and a New Rule Concerning Magnetostriction and Magneto-Resistance

IT is considered an open question[1] whether the Weiss–Heisenberg model or the band model, which is based on the conception of the itinerant electron, is the more appropriate one for the description of ferromagnetic phenomena. On the whole, the original Weiss treatment translated into modern language is surprisingly powerful when compared with numerous later attempts at an improvement.

It occurred to me that arguments for or against the Heisenberg model might be derived from a consideration of the properties of ranges of alloys in which the mean number of Bohr magnetons passes through an integral value. The Heisenberg model leads one to expect that the exact filling up of all lattice-points with an equal number of electrons will make itself felt in some properties of the ferromagnetic alloy. From the point of view of the band theory, however, a singling out of such an alloy from its neighbouring alloys is pointless, there being no reason why this particular alloy should be different from other alloys. We therefore have here a suitable criterion at hand for deciding between both theories.

In order to have a reasonable chance of finding such a singularity at integral values of the mean number of Bohr magnetons, it is, of course, preferable that the alloy components shall be chemically as much alike as possible, and that the lattice structure should be a simple close-packed arrangement.

The above conditions are fully met by a nickel–cobalt alloy containing 33 per cent of cobalt[2], by a nickel–iron alloy containing 18 per cent of iron[3] and approximately by an alloy of composition Ni_3Mn in the ordered arrangement[3]. In the first two of these alloys, the mean number of Bohr magnetons is equal to one, in the third it comes close to one (about 0·95).

From a survey of the available literature[4,5,6], it became at once clear that our criterion leads to alloys having zero magnetostriction, a most remarkable result indeed. For the nickel–cobalt series the agreement between the two critical concentrations at first seemed rather poor. As pointed out by Kühlewein[7], however, the existing very old data on the magnetostrictive properties of nickel–cobalt alloys are not to be trusted, probably due to lack of purity of the cobalt. Control measurements which have been carried out on high purity nickel–cobalt alloys by J. J. Went of this Laboratory have confirmed our expectation[8].

An extended search in the literature further brought to light that at the concentration where $\lambda = 0$ (and accordingly $n_B = 1$), the change in the electrical resistance due to the application of a magnetic field passes through a maximum.

For the nickel–iron series only measurements carried out at room temperature are available[9], and even these are scanty. On nickel–cobalt, however, extensive measurements have been carried out by Shirakawa[10] at various temperatures down to −195° C. At this temperature the effect is very pronounced, and the maximum change observed (16 per cent) is found to occur in alloys with between 30 and 40 per cent of cobalt. At room temperature the maximum is much weaker (only 5 per cent), and at 300° C. it is no longer observable.

It is tempting to speculate a little further on the anisotropy of the magnetostriction as observed by Lichtenberger[11] on single crystals of nickel–iron. Apart from minor discrepancies, Lichtenberger's results can be adequately summed up in the following statement: apparently the absolute value of λ always has a minimum value in the direction where the internal energy also has a minimum value.

An extension of the results obtained above to other cases is difficult and of doubtful value. Alloys of ferromagnetic components, having, in the mean, two Bohr magnetons instead of one, no longer have a close-packed structure, but are cubic body-centred. All the same, on the whole the magnetostriction seems to be small also in those alloys, so there is no contradiction. For alloys of a ferromagnetic component with an unmagnetic component, one does not expect a simple rule like the one stated above to hold, because of the very different character of the components. Indeed, it is found that their behaviour is quite different from that of alloys having only ferromagnetic components.

Alloys like Fe–Pt, where n_B is also found to pass unit value, are subject to phase transformations and therefore difficult to investigate.

It is felt that the observed near coincidences in the nickel–cobalt, nickel–iron and nickel–manganese binary systems, as well as the above provisional rule on the anisotropy of the magnetostriction, may perhaps serve as a starting point for a theory concerning these phenomena.

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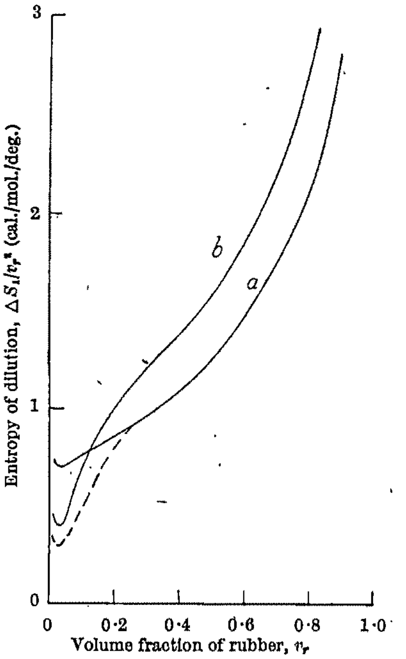
Entropy of Dilution of a Polymer-Solvent System

IN examining the properties of polymer-solvent systems, considerable attention has been given in the last decade to the evaluation of the configurational contribution to the partition function. It has been shown[1] that the greater part of the divergence of these systems from ideal behaviour is due to the vast differences in the sizes and shapes of the molecules of the polymer and of the solvent. This configurational contribution exercises a dominating influence on the thermodynamical properties of polymer-solvent systems. The rubber–benzene system has been most thoroughly investigated experimentally. The theory reproduces the observed behaviour of the free energy, and also the general trend of the entropy at ordinary concentrations (see ref. 1, sections 4.6, 4.9, 4.10 and 6.11); but in very dilute solution, the experimental measurements show a feature which is not reproduced by the theory. This is made clear by the theoretical (*a*) and experimental (*b*) curves shown by the *full* lines in the diagram. In this note, the effect responsible for the dip in the experimental curve in dilute solution is determined; its effect is shown by the dotted curve in the diagram. From this it can be seen that the new theoretical curve reproduces the shape of the experimental curve throughout the whole concentration-range.

In first deducing an unambiguous expression for the combinatory factor, and the various thermodynamical quantities of interest, it was shown[2] that the significant parameter was the number of closest neighbour interactions or contacts which one polymer molecule shares with its surroundings. For simple-chain and branched molecules, the number of closest neighbour interactions zq is given by

$$zq = zr - 2r + 2, \qquad (1)$$

where z is the co-ordination number of the quasi-crystalline model of a liquid and r is the number of segments in a polymer molecule. For very large values of r, appropriate to a high polymer, the ratio of the number of external contacts of a molecule to the number of sites occupied by it is almost exactly $z - 2$. This assumes, as is the case at ordinary



concentrations, that the polymer molecules are spread out and intertwined throughout the system.

There is evidence[3] that in dilute solution the polymer molecules tend to segregate, to coil up and to form clusters. My view has been (see ref. 1, sections 6.3 and 6.6) that the discrepancy, in the region of very dilute solution, between the theoretical and the experimental entropies was due to this change in the configurational properties of the individual polymer molecules as the concentration varied; that it did so through a reduction in the number of contacts of each polymer molecule; and that this gave rise to the observed variation of the heat of mixing of the rubber–benzene system.

Coiling of the polymer molecules in dilute solution implies physically that the number of external contacts is greatly reduced. This reduction will occur over a small concentration-range. Its effect can be seen in the following way. The entropy of dilution for a polymer-solvent system can be written, in terms of the parameters which define the polymer molecule, in the form

$$\frac{\Delta S_1}{R} = -\log(1-v_r) - \frac{r}{r-q}\log\left(1-\frac{r-q}{r}v_r\right). \quad (2)$$

(This is simply equation (4.24) of ref. 1, making use of equation (1) above.) If the right-hand side of this equation is expanded as a power series, the term in v_r vanishes; it is to this fact that the particular form of the entropy in such a system is due. Expanding the right-hand side, we get

$$\frac{\Delta S_1}{R} = \frac{1}{2}\frac{q}{r}v_r^2 + \frac{1}{3}\frac{q}{r}\left(2-\frac{q}{r}\right)v_r^3 + \ldots \quad (3)$$

Thus, the value of the entropy of dilution depends immediately on q/r, that is, on the ratio of the number of external contacts of a molecule to its number of segments. It is clear that if, as the system is diluted with solvent, the number of external contacts of a polymer molecule falls, owing to the fact that it coils up, then the entropy must assume a lower value than it would otherwise have. In fact, to a first approximation, the entropy will be lower than that calculated, assuming the fixed value of q given by equation (1), just in the ratio that the number of contacts has diminished. Assuming that the configurational properties of individual polymer molecules begin to change markedly at about $v_r = 0{\cdot}25$, corresponding to a molar concentration of the order of 10^{-3} or 10^{-4}, the theoretical curve now assumes the form shown by the dotted line in the diagram. The diagram shows that when this effect is allowed for, the theory reproduces the form of the experimental results completely.

The importance and usefulness of this concept of the number of contacts of a polymer molecule had been suggested previously[2,4] in other connexions; it clearly has other applications. For flexible polymer molecules there is self-blocking of some possible configurations owing to the polymer molecule bending back on itself[5,6]. This reduces the number of contacts of each polymer molecule; from the considerations which have been advanced in this note, it needs no elaboration to see that the effect must be very small. The same concept can be used also to consider systems of roughly spherical molecules which differ greatly in size, as is common in biological systems. In this case, the departure from ideal behaviour will be very much less than for a polymer–solvent system which has the same molecular volume ratios. The analysis given in this note also shows that there is no justification for suggesting[7] that the agreement between the experimental and theoretical free energy curves is due to a fortuitous cancelling of errors.

The configurational properties of the system, arising from the different shapes and sizes of the molecules of the polymer and of the solvent, are the dominating influence in the departure of polymer–solvent systems from ideal behaviour. The dependence on concentration of the configurational properties of individual polymer molecules can be adduced to account for the dip in the experimental curve for the entropy of dilution, which was not given by the basic theory used previously.

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Metastable States of Nickel

In view of the recent communication by Snoek and Fast[1] on their observation of the metastable states in *well-annealed* nickel, it may be of interest to record a similar effect which was noted in the course of some investigations on nickel magnetostrictive oscillators. These experiments, made just over a year ago, were essentially of a dynamic type, in contrast to the static conditions used by Snoek and Fast.

The specimen was a consolidated stack of laminations mounted on a pin at the central node, and it was excited at its resonant frequency (10·7 kc./s. at room temperature with zero polarizing field) by a beat-frequency oscillator applied to a driving coil closely encircling the stack. The E.M.F. induced by the motion of the stack in a screened 'pick-up' coil

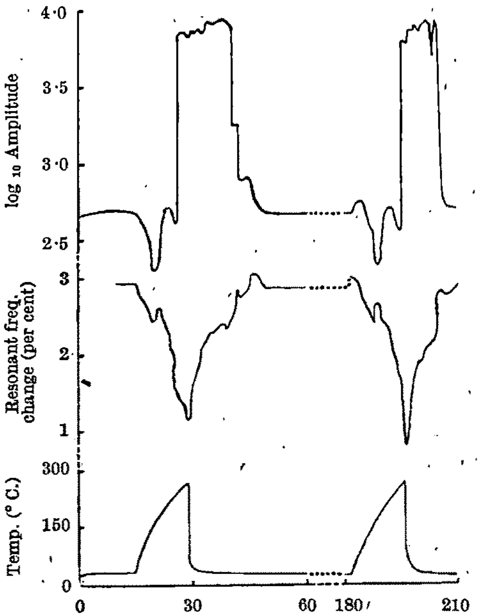

Fig. 1. Onset of metastable state with temperature rise (polarizing field 280 oersteds)

is proportional to the amplitude and also to the square of the dynamic magnetostriction constant, λ, as defined by the relation $\delta p = \lambda \delta H$, where δp is the incremental stress resulting from a small change δH in the applied magnetic field.

Magnetic polarization of the specimen was effected by passing a direct current (maximum value 7 amp.) through additional coaxial coils, the maximum polarizing field being 280 oersteds. At the higher currents used, considerable heat was developed in the polarizing coils, causing a rise in temperature of the stack. The surface temperature was measured by a contact thermocouple.

Typical curves are shown showing the variations with time in the amplitude of motion as the temperature varied, for the case of a laminated bar made from pure *cold-rolled* nickel sheet 0·005 in. thick. It will be seen that following a rapid rise of temperature (brought about by shutting off the forced-air cooling system), there is a large increase in λ, which it is possible to maintain for a period of hours or even days. This effect was not obtained with similar experiments made on a number of nickel alloys.

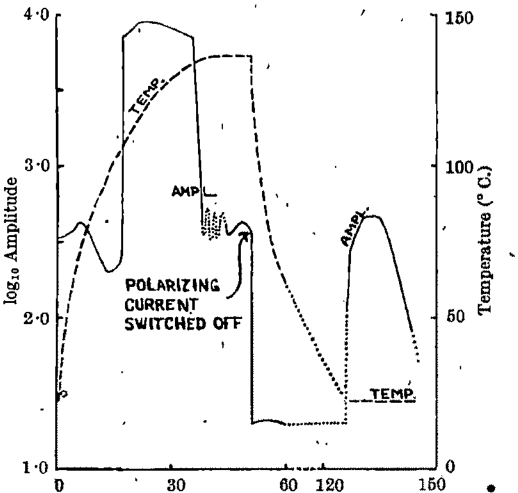

Fig. 2. Recurrence of metastable state after nickel has cooled (polarizing field 200 oersteds)

It may be found that these metastable conditions can be employed for a highly efficient magnetostrictive transducer, which could be used in special circumstances where the higher temperatures do not present any difficulties.

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Decay of Thulium-170 and Rhenium-186

THE decay of the 127-day thulium isotope (Tm^{170}), has been previously investigated by Bothe[1], and that of the 93-hour rhenium isotope (Re^{186}) by Goodman and Pool[2]. In both cases absorptio methods were used.

The present investigations were carried out by means of absorption and coincidence techniques, and also by means of a short magnetic-lens β-ray spectrometer.

A summary of our results appears below:

	β-rays	γ-rays
Tm^{170}	1·00 ± 0·01 MeV. 0·90 ± 0·015 0·79 ± 0·03 0·45 ± 0·05	82·6 ± 0·7 keV. 200 ± 10 440 ± 20
Re^{186}	1·095 ± 0·010 MeV. 0·945 ± 0·015 0·64 ± 0·030	132 ± 1 keV. 275 ± 5

A more detailed account of this work will appea shortly.

We wish to express our appreciation of the hel given by members of the Atomic Energy Researc Establishment, Harwell, where the active sample were prepared by slow neutron irradiation in th low-energy pile.

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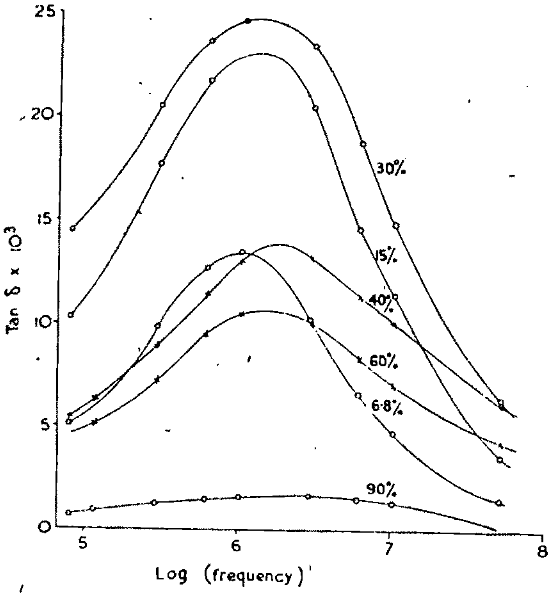
Dielectric Absorption in Crystalline Long-Chain Ketones

FOR dilute solid solutions of long-chain pola compounds in paraffins, it has been shown that th rotational transitions of the polar molecules from one position of minimum potential energy to anothe lead to dielectric absorption of the Debye type[1,2]. A theoretical study has also been made[3,4] of the dielectric properties of pure crystalline compounds, in which dipolar interaction is an important factor.



Dielectric absorption at 20° C. for a range of concentrations of laurone in *n*-hexacosane

In order to investigate the effects of dipolar interaction, it seemed desirable to make dielectric measurements with mixtures containing a gradually increasing proportion of polar molecules. The accompanying graph shows the frequency / tan δ relationships for a series of concentrations of the ketone, laurone ($C_{23}H_{46}O$), in a non-polar solvent, *n*-hexacosane. The measurements were made at 20° C., and over the frequency-range, 60 kc./s. to 50 Mc./s. It is seen that the dielectric loss at first increases with increasing concentration but later decreases, pure laurone giving negligible loss within this range.

With concentrations up to at least 15 per cent, the majority of the laurone molecules are probably surrounded by non-polar solvent. The rapid increase of the maximum tan δ with concentration in this ange suggests that solute molecules thus situated are able to perform rotational transitions leading to dielectric absorption in an alternating electric field. A small proportion of the ketone molecules, however, occupy adjacent positions in the crystal lattice, and he resulting dipole interaction probably causes a very high energy difference, *V*, between equilibrium positions. The probability of finding such molecules in a higher equilibrium position is thus small, and they therefore contribute little to the polarization. As the concentration of laurone increases, the proportion of adjacent molecules increases rapidly, the effect on the polarization being indicated by the dielectric absorption results given. It is probable that pure crystalline laurone provides an example of the type treated theoretically by Fröhlich[5], in which, even at room temperature, $kT \ll V$, and there is no dielectric loss of the Debye type. Similar results were obtained with the ketones, myristone ($C_{27}H_{54}O$), palmitone ($C_{31}H_{62}O$), stearone $C_{35}H_{70}O$) and 22-tritetracontanone ($C_{43}H_{86}O$).

In contrast to the ketones, several long-chain esters gave strong absorption of the Debye type. The maximum tan δ and frequency values for three such compounds are given in the accompanying table.

Ester	Tan δ (max.)	Frequency (max.)
Dodecyl laurate, $C_{24}H_{48}O_2$	$1 \cdot 4 \times 10^{-2}$	3 Mc./s.
Dodecyl myristate, $C_{26}H_{52}O_2$	$4 \cdot 0 \times 10^{-2}$	600 kc./s.
Cetyl palmitate, $C_{32}H_{64}O_2$	$1 \cdot 5 \times 10^{-2}$	100 kc./s.

Thus, with these esters, the energy difference between equilibrium positions is probably less than in the ketones of corresponding chain-length, and a significant proportion of the molecules are to be found in the second position. This suggests that dipole interaction in the esters is less than in the corresponding ketones.

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Potassium and Neuromuscular Transmission

IN a study of the effects of ions on the rat diaphragm, it has been found that denervated preparations are much more sensitive to potassium than the normal diaphragm stimulated through its nerve. A dose of potassium, for example, exposure to a concentration of 0·08 per cent in Krebs's solution, which has no depressant action on normal muscle, may completely depress the response of denervated muscle to electrical stimuli while its response to acetylcholine remains. Observations have now been made on diaphragms denervated functionally by curare, which prevents the action of acetylcholine, or by lack of glucose, which prevents its synthesis or release. The effect is the same in both cases. If now, however, the experiment is reversed and the potassium added first, it is found that after curare, or through lack of glucose, which abolish neuromuscular transmission, the muscle has become inexcitable. The exact cause of this somewhat dramatic finding is not certain.

An obvious suggested explanation of these facts might be that potassium and curare have a synergic action, or that acetylcholine and potassium oppose each other. Another explanation would be that the potassium does, in fact, render the muscle inexcitable to direct stimulation in all cases, but it can remain excitable to nerve stimulation only. This explanation is supported by preliminary observation that, although after potassium the muscle contracts normally, its resting potential is reduced by one third, as shown also by Boyle and Conway[1], and its action potential is negligible. This latter observation is in accordance with that of Brown and Euler[2], that action potential may be reduced by potassium while the muscle tension is increased.

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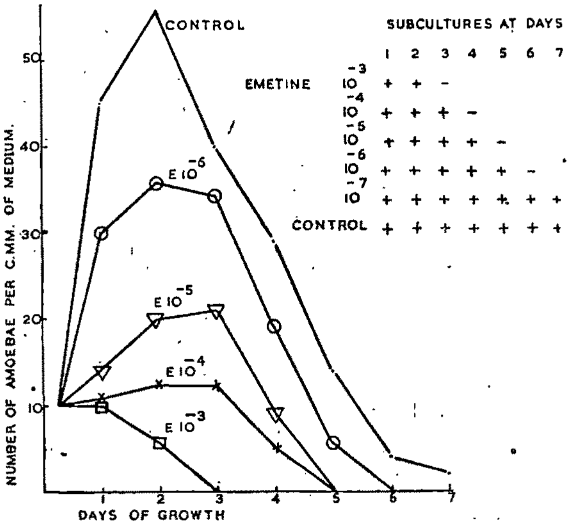
Nature of the Action of Emetine upon *Entamœba histolytica*

THE fact that emetine exerts a powerful toxic action upon *E. histolytica*, *in vivo* and *in vitro*, has long been established[1,2]. The mechanism of this action, however, is far from clear[3]. Furthermore, the end-point of toxicity of emetine to *E. histolytica* is variable *in vitro*, depending upon such factors as the nature and reaction of the medium, time of observation, and composition of the bacterial flora which necessarily accompanies the growth of the amœba in culture[2,4].

In the experiments reported below, emetine hydrochloride was added (*a*) to cultures of *E. histolytica* in a basic medium of horse serum, rice starch and saline buffered with phosphate to *p*H 7·2, and (*b*) to suspensions, prepared from such cultures, with a cell density of 150–300 per c.mm. Ten strains of *E. histolytica* were used, each having been isolated originally from cysts in human fæces. One strain (*M*) was grown with *Bact. coli* plus *Cl. welchii*; the other strains included in their bacterial flora non-lactose-fermenting coliforms, *Ps. pyocyaneus*, enterococci and *Clostridia*. Acting in the basic medium, emetine did not inhibit the growth or respiration of these bacteria, individually or in combination.



At *p*H 7·2, emetine (in dilutions ranging from 10^{-6} to 10^{-7}) sterilized cultures of *E. histolytica* in three to seven days. A study of growth curves showed that this effect was due to a reduction of the propagation-rate (see graph). No division occurred at dilutions of 10^{-3} to 10^{-4}; at higher dilutions there was a progressive increase in the rate of division, and dilutions higher than 10^{-7} showed no difference from control cultures. The addition of cysteine (0·02 per cent) did not antagonize the action of emetine.

When emetine was added to suspensions of *E. histolytica*, there was no change in the morphology of the cells, and subculture of washed cells was always positive during the first four hours. Thereafter, at dilutions of 10^{-3} or less, emetine produced conspicuous degenerative changes in 80–100 per cent of the cells, clearly shown in fresh or iron–hæmatoxylin preparations. Bi-nucleate or dividing cells were absent, and, after 48 hours, subculture was negative. With higher dilutions, there was a proportionate decrease in the number of degenerate cells; dividing cells were present and subcultures made after 48 hours were positive, as in the controls. The morphologica changes observed were, in order of appearance: loss of motility, vacuolation, coarse granulation and central retraction of cytoplasm, loss of nuclear differentiation, and disintegration. These morphologica changes were not specific for emetine, since cells comparable in appearance though not in numbers were seen in the control suspensions, especially after 24–48 hours, when the death-rate rose sharply.

From these observations it would seem that emetine does not exert an immediate toxic action upon *E. histolytica* in the fashion of a general protoplasmic poison. It does, however, have an 'amœbostatic' effect, absolute at a dilution of 10^{-3} but still evident at 10^{-7} with some strains. Cultures growing in the presence of emetine are sterilized more rapidly than controls for the reason that the cell count reaches a lower maximum, and the culture dies sooner. The end-point of survival of such a culture is determined by the ratio of propagation-rate to natural death-rate of the cells. The cell envelope remains intact, and motility is preserved in the majority of the cells for four hours in the presence of emetine. Surviving cells, transferred from an emetine medium after 24–48 hours, grow normally Emetine does not produce a definite stage of mitotic arrest, and its action is not antagonized by cysteine an —SH donor. It seems likely, therefore, that emetine acts upon *E. histolytica* by a highly specific interference, in proportion to its concentration, with some essential cytoplasmic reaction at a phase in the growth of the cell prior to cell division.

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Effect of the *Striga* Germination Stimulant on Extension Growth on the Roots of Peas

THE seeds of *Striga hermonthica*, like those of certain closely allied parasites, will normally only germinate after they have been treated with a stimulant that is released from the roots of a large variety of species[1]. The situation suggests that the parasite seed is supplied from actively growing hos roots with a hormone which is normally required i germination but which is not synthesized by the seed[2]. Moreover, the hormone only acts at a comparatively late stage in the germination process, anc then it has the effect of promoting the extension o the cells of the radicle. When the radicle emerges, a first there is no division at the apex, and the increase in length is apparently due primarily to cell extension Thus the hormone may be one that promotes cel extension in the root of *Striga*, and since it is produced from a large variety of species it may be one that stimulates extension growth in roots in general[2]

This possibility has been investigated by treating segments of pea roots taken from the extending zone with various dilutions of a solution of a concentrate of the hormone. The segments are obtained by cutting out of intact roots the zone extending from 1·5 to 3·0 mm. from the tip. Observations can be made rapidly with this material, and extension growths in the root can be studied independently of the tip, both considerations being of importance since the available evidence suggests that the hormone is produced in the tip and that it is highly labile. In the normal procedure, the segments after they are excised are placed on sintered glass disks standing in the experimental solutions, twenty segments being allocated to each disk. After incubating for 18 hr. at 25° C. in the dark, the segments are examined microscopically, and the length and breadth of each is measured against a calibrated micrometer eyepiece. Each figure given below is the mean of twenty observations made with each treatment.

The mean lengths and breadths (mm.) given with various dilutions of the concentrate and with water are presented in Table 1, which also includes the calculated percentage increases in volume over the original volume at the beginning of the experiment. It will be noticed that at a concentration of 10 mgm./litre the preparation of the natural stimulant gives a volume increase considerably greater than that of the control with distilled water (in Table 1 the differences in the group of means for breadth are not significant, but those for length are highly significant).

Table 1.

Concentration (mgm./litre)	Length	Breadth	Percentage increase in volume
0 (Control)	2·17	1·10	55·9
100	2·25	1·10	61·5
10	2·35	1·13	81·1
1	2·12	1·11	57·8
0·1	2·14	1·10	53·7
0·01	2·15	1·11	60·0

The stimulant involved in the germination of the *Striga* seeds has not been isolated in the pure state; but it has been found that concentrates of the natural stimulant that give germination at high dilutions contain pentose sugars which are probably not aldopentoses, and that D-xyloketose may induce germination at lower concentrations than the purest preparations of the natural stimulant that have so far been made[3]. Thus it is probable that the natural stimulant is at least similar to D-xyloketose, and the effect of this sugar on the extension of pea root segments has therefore been examined in some detail. The results of two experiments with xyloketose conducted with the technique described above are shown in Table 2. It is evident that at appropriate concentrations of D-xyloketose, increases in length and breadth, and therefore of volume, are given that are considerably greater than the corresponding increases given with water. (The differences in the means for length are highly significant for both *A* and *B*; for breadth they are not significant for *A* but highly significant for *B*.) Moreover, it may be noted that stimulation of extension growth is given with concentrations so low as 0·1 mgm./litre.

Table 2

Concentration (mgm./litre)	Length		Breadth		Percentage increase in volume	
	A	*B*	*A*	*B*	*A*	*B*
0 (Control)	2·33	2·15	1·08	1·10	65·1	51·6
1000	2·42	2·34	1·07	1·15	70·9	79·1
100	2·39	2·22	1·08	1·14	70·7	68·6
10	2·48	2·37	1·09	1·15	80·5	83·3
1	2·59	2·30	1·12	1·13	99·1	71·6
0·1	2·38	2·22	1·09	1·10	73·9	56·8
0·01	2·31	2·20	1·09	1·10	67·3	55·9

All results obtained with the natural stimulant have shown some increase in breadth at certain concentrations of the stimulating solution. In certain instances the increases in breadth are not statistically significant; but they have been observed repeatedly, and they are a characteristic of the stimulation due to this hormone. With pea-root segments, heteroauxin may give a slight increase (less than with D-xyloketose) in length at a concentration of 0·001 mgm./litre, but increases in breadth have never been observed. Indeed, the breadths of the treated segments are always lower than those of the water controls for all concentrations of heteroauxin greater than 0·0001 mgm./litre. The differences between the volumes of the segments treated with heteroauxin and those of the water controls are rarely as great as 10 per cent, whereas the corresponding differences between those treated with D-xyloketose and the controls are rarely less than 30 per cent, and may be as high as 60 per cent at the appropriate concentrations.

Finally, so far as we know, this is the first record of a stimulating effect on the growth of plant tissues of a simple sugar in concentrations of less than 10 mgm./litre.

We wish to express our thanks to the Colonial Products Research Council for financial support in this investigation, and to Mr. A. G. Long for preparing some of the samples of D-xyloketose that have been used.

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Free Amino-acids in the Hæmolymph of *Calliphora erythrocephala* Meigen

The recent publication by Raper and Shaw of an analysis of the amino-acids of the hæmolymph of the nymph of *Aeschna cyanea*[1] prompts us to report a similar investigation we have carried out upon the hæmolymph of the larva of *Calliphora erythrocephala*. The larvæ used for this study were inbred descendants of a single female and were reared on ox liver at 25° C. for 4–5 days. The amino-acids were separated and identified by paper partition chromatography.

About fifteen larvæ were washed with water and then each larva was bled on to a small strip of filter paper by puncturing the heart with a needle. These papers were dropped into 90 per cent alcohol, and so a clear solution of the free amino-acids was obtained; the protein constituents remained adsorbed on the filter paper. This solution was concentrated to about 0·15 ml. on a water-bath or, preferably, at room temperature *in vacuo*, and then 20-c.mm. samples of this were used for analysis. One- or two-dimensional chromatographic analysis was carried out by the ascending technique[2] using phenol ammonia, *n*-butanol-acetic acid (4/1, by volume), collidine–lutidine (1/1, by volume) as solvents. The papers were dried and finally developed by spraying with ninhydrin. The accompanying table lists the amino-

Amino-acids	Proportion	Amino-acids	Proportion
Alanine	2·5	Phenylalanine	0·5
Tyrosine	2·0	Glycine	0·3
Proline	1·0	Leucine	0·3
Valine	1·0	Lysine	0·2
*iso*Leucine	0·7	Serine	0·2
Histidine	0·5	Aspartic acid	0·1

acids identified and gives an estimate of their relative proportions by weight.

There are several interesting features about the results of this analysis. Phenylalanine has not previously been found in hæmolymph in other larvæ, for example, *Dytiscus marginalis*[3], *Oryctes nasicornis*, *Melolontha vulgaris*[4] or *Aeschna cyanea*[1]; but in this case it occurred in appreciable proportion. It is of interest to note that Goldberg and de Meillon have recently shown that phenylalanine is essential for the growth of the larvæ of *Aedes ægypti*[5]. The same workers showed that cystine and methionine were necessary constituents of the diet. It seems surprising that neither of these amino-acids has, as yet, been detected in any hæmolymph.

Florkin and Duchateau[3] have reported the tyrosine concentration in the hæmolymph of *Dytiscus marginalis* as 117–168 mgm. per cent. Taking their value of 106 mgm. per cent amino-acid nitrogen, our results would correspond to about 150 mgm. per cent tyrosine, a value comparable with their result. Such a concentration seems abnormally high when compared with the solubility of tyrosine in water (45 mgm. per cent at 25° C.). The proportion of tyrosine reported in our table was confirmed by direct comparison with the valine using spot-dilution technique.

The presence of both leucine and *iso*leucine was shown by separation of the 'leucine fraction' by one-dimensional chromatography; then, after extraction from the paper, the two were separated by further chromatography using benzyl alcohol. The trace of histidine was detected by treating the appropriate region of the paper with diazotized sulphanilic acid in sodium carbonate solution. Histidine then shows as an orange-red coloured spot.

This work is part of an investigation of the nutrition of tissues. It is hoped to study the metabolism of both insect and mammalian tissues *in vitro*.

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Department of Zoology,
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Use of Wetting Agents against Heath and Undergrowth Fires

Suggestions have been made[1] that by the addition of wetting agents an economy can be achieved in the use of water in fire fighting, particularly with heath and undergrowth fires. Preliminary experiments which we have recently completed indicate some of the probable limitations of this proposal, and also suggest fields in which it might have some practical use. The combustible materials used were ling (*Calluna vulgaris*), bracken (*Pteridium aquilinum*) and purple moor grass (*Molinia cœrulea*); the samples were provided by the Forestry Commission at the end of the winter and after a long dry spell, so that they were in their most dangerous condition from the point of view of the forest fire-fighter.

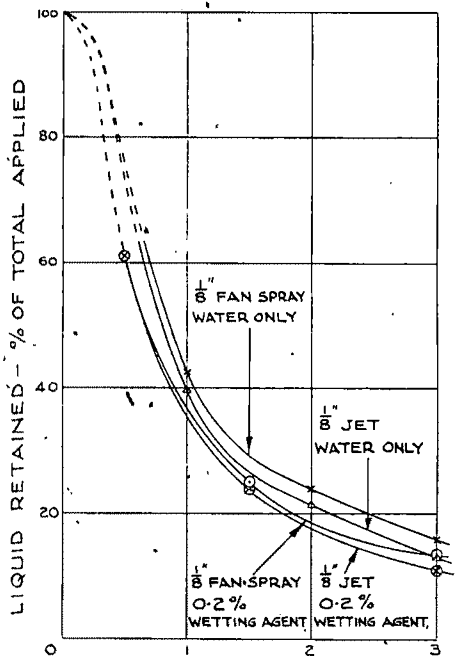
Three series of experiments were carried out: (i) extinction of fires; (ii) prevention of spread of fire; and (iii) wetting of dry materials at normal temperature (that is, without fire).

In each series a comparison was made between the effectiveness of water and that of a solution of each of three commercial wetting agents (one non-ionic and two anionic), and of application in the form of a jet and as a spray. The wetting agents were used in 0·2 per cent aqueous solution, since increases in concentration beyond this point did not greatly reduce the surface tension with any of the agents used.

For the fire extinction experiments, the material was spread on a circular area of ground, and was ignited at the centre. The fire was attacked when its diameter was approximately half that of the circular area. No significant difference was observed between water and the wetting agent solution, either in the time taken to extinguish the fire or in the amount of liquid used.

For the second series of experiments, a 6-in. layer of *Molinia* was spread in a rectangular colander, 4 ft. long × 2 ft. wide. Liquid was applied by means of a spray for a predetermined period to one half of the specimen, the other half being covered. At the end of the wetting period, the cover was removed from the dry half, which was then ignited. It was found that the quantity of liquid required to prevent the advance of flame from the dry to the wet zone was half as much with the wetting agent solution as with water.

In the third series of experiments, a 6-in. layer of each of the materials investigated was placed in the colander, and liquid was applied for a given period as either jet or a spray, and the quantity retained in the sample was determined by difference in weight before and after application. Typical



Retention of liquid in samples of ling

Results with ling are shown in the accompanying graph; little difference was revealed between the behaviour of wetting-agent solutions and water.

Within the scale of the experiments it was apparent hat, though wetting agents gave no advantage in ire extinction, they may well prove to be of value in ontrolling heath fires by the technique of wetting he unburnt materials ahead of the fire. This is reasonable in view of the fact that, whereas the small quantities of wetting agent used can have little effect upon the thermal properties of the water, the reduction in surface tension which they bring about is likely to result in improved dispersion within the ombustible material even when it causes no appreciable change in the total quantity of liquid retained.

It is intended to examine further the efficacy of wetting agents in similar materials of different specific urface.

This letter is published by permission of the Director of Fire Research.

J. F. Fry
P. M. T. Smart
Department of Scientific and Industrial Research,
and
Fire Offices Committee,
Joint Fire Research Organisation,
Boreham Wood, Elstree, Herts.
Dec. 4.

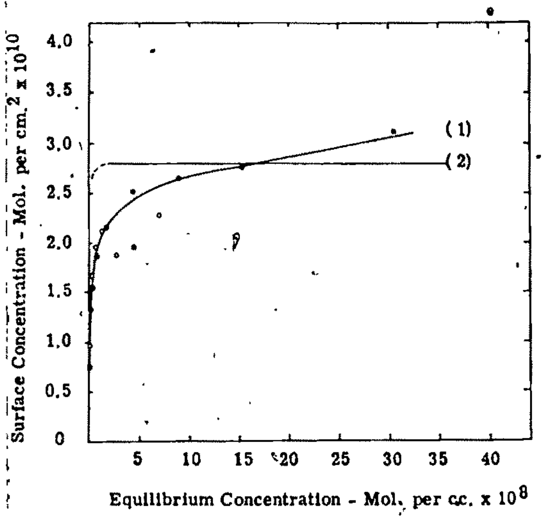
For example, Edson and Parker, *Fire Engineering* (August, 1947)

Measurement of the Adsorption of Surface-Active Agent at a Solution – Air Interface by a Radiotracer Method

The adsorption of a water-soluble surface-active agent at a solution – air interface has been measured by taking unique advantage of the soft beta radiation from the radioactive isotope of sulphur, S^{35}. The method depends upon the fact that, because of 'self-absorption' of the radiation by the solution, the amount of radiation escaping from a solution of a compound containing this isotope comes principally from that fraction of the sulphur which is near the surface. Since the molecules of a surface-active agent are preferentially adsorbed at the interface, the radioactivity above a solution containing such an agent labelled with radiosulphur should be higher than the activity from a solution (for example, of sodium sulphate) in which no surface adsorption occurs.

To investigate this idea experimentally, di-*n*-octyl sodium sulphosuccinate ('Aerosol OTN') and sodium sulphate were each synthesized with sulphur-35 procured from the U.S. Atomic Energy Commission). A pure 2–3-mgm. sample of the surface-active agent was secured by five recrystallizations from alcohol – water solutions. Activity measurements were made by placing a mica-window bell-type Geiger counter over small open pans containing the solutions. Measurements were carried out on solutions of the sulphosuccinate and of sodium sulphate having identical concentrations and specific activities. Since the sulphate is not adsorbed at the interface, a comparison of the radioactivity of its solution with that of the surface-active agent permitted a calculation of the amount of agent adsorbed in the interface.

The experimental results showed that the radiotracer technique permitted a successful quantitative determination of the adsorption. Depending upon the specific activities and the concentrations, the counts per minute (c./m.) over the solutions of agent were 1·1 to 20 times those of the corresponding sodium sulphate. For example, in one case the sulphosuccinate solution showed 2,360 c./m., the sulphate solution only 323 c./m. Measurements of some thirty-five different solutions covering a range of specific activities (1×10^{12} to 5×10^{9} counts/min./mole) and of concentrations ($0 \cdot 1$ to 150×10^{-8} moles/c.c.) produced a well-defined adsorption isotherm. It is shown in the accompanying graph, along with an isotherm calculated by the conventional Gibbs equation from surface tension measurements covering the concentration range 4 to 50×10^{-8} moles/c.c. The radioactivity measurements suggested that, after the agent had formed a unimolecular layer, a further increase in bulk concentration caused further adsorption at the interface.



Adsorption isotherm for aqueous solutions of di-*n*-octyl sodium sulphosuccinate. The radioactive isotherm, Curve No. 1, continues without change of slope to a concentration of 150×10^{-8} mol. per c.c., at which point a surface concentration of $5 \cdot 5 \times 10^{-10}$ mol. per cm.² is indicated. The surface tension isotherm, Curve No. 2, remains horizontal to the critical concentration (65×10^{-8} mol. per c.c.). (Temperature, 24° C.)

An interesting aspect is that the rate of adsorption was followed in the low-concentration ranges. The method promises to be useful for studying the kinetics of such adsorption processes.

The radiotracer method outlined above seems to be generally applicable to surface phenomena involving adsorbed layers, either mono- or multi-molecular in nature. Although this note describes the use of sulphur-35, it is evident that other radio-isotopes having sufficiently soft radiation, such as carbon-14, calcium-45, iron-59, etc., could be employed. Moreover, the method appears to open considerable possibility for examining interaction in surface layers. For example, by using labelled sulphate, the adsorption of sulphate ions in the surface layer in a solution containing both cetyl pyridinium chloride and sodium sulphate has already been measured. The application of the method to the study of surface phenomena in bubbles and in systems containing several surface-active materials is under consideration.

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Feb. 21.

Quantitative Chromatographic Analysis of Tetra-, Tri- and Di-methyl Fructoses

In a recent report by Gilbert and Stacey[1] on the constitution of a bacterial levan, these authors state that a convenient chromatographic technique for the quantitative analysis of tetra-, tri- and di-methyl fructoses had so far eluded them. We have devised a partition chromatogram giving quantitative results in the analysis of mixtures of 1 : 3 : 4 : 6-tetramethyl, 1 : 3 : 4-trimethyl and 3 : 4-dimethyl fructoses which is applicable to the study of methylated fructosans based on these sugars. (3 : 4 : 6-Trimethyl fructose has also been examined; but certain difficulties, not yet overcome, arise in analytical separations involving this sugar.)

In principle, the method resembles the separation of methylated glucoses devised by one of us[2], but it differs in practice in two important respects. First, the partitions of the sugars concerned between organic solvents and water necessitate use of a different series of solvents for the mobile phase; and secondly, 1 : 3 : 4 : 6-tetramethyl fructose has appreciable volatility at reduced pressures, both in the dry state and in concentrated solutions, but not in dilute solutions.

The essential steps in our method are as follows. (1) The solution of the sugars is extracted ten times with its own volume of chloroform. The chloroform phase is concentrated (bath temp. 30°) to 50 ml. (no loss occurs). The chloroform is then displaced by distillation with toluene at low temperature (final volume about 50 ml.). This is pipetted on to a silica – water column prepared from a slurry of silica, containing half its weight of water, and toluene.

(2) The tetramethyl fructose is eluted by passing sixteen column-lengths of toluene containing 0·33 per cent of ethanol. The eluate is concentrated (30° C.) to 50 ml. and extracted eighteen times with 50-ml. lots of water, and the combined water phases made up to a known volume. The sugar is then estimated colorimetrically, taking an aliquot of the water phase containing approximately 0·4 mgm.

(3) The water phase from (1) is evaporated to dryness (30° C.), the residue dissolved in a little chloroform and this solution pipetted on to the column. The total trimethyl fructose is then eluted by means of eight column-lengths of chloroform containing 5 per cent (v/v) of *n*-butanol. The eluate is evaporated to dryness (30° C.), some water being added to aid removal of the butanol. The residue is dissolved in ether and this solution evaporated to dryness in a tared evaporation-flask[2]. The dried sugar is then weighed.

(4) Dimethyl sugars are extracted from the column by methanol. This solvent is evaporated, and an ethyl acetate solution of the residue is evaporated and weighed as for the trimethyl sugar.

Recoveries for all three sugars are of the order of 98 per cent (scale of working 100–1,500 mgm.). In every instance the sugars were shown by paper chromatography[3], optical activity and analysis to be pure. A full account of this work is in preparation.

D. J. Bell
A. Palmer

Biochemical Laboratory,
Cambridge.
Dec. 1.

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[2] Bell, D. J., *J. Chem Soc.*, 473 (1944).

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The Teaching of Biology in Schools

I was surprised at the warmth of the hostility with which Prof. Graham Cannon reviewed my pamphlet "Social Biology for Sixth Forms" in *Nature* of April 9, p. 577.

The problem which my paper attempts to answer is this. Supposing that a headmaster will allow a biologist two periods a week to lecture to sixth-form boys specializing in history, classics, mathematics or modern languages, what should he attempt? In my view the answer to this question must take account of three things.

First, the interests of these boys are mature interests. They want to put the questions to a biologist that an adult would ask. Secondly, if biology is worth a place in their education at all, it is because it has implications which affect their philosophy, politics and understanding of history and world problems of the day, such as soil erosion or food supplies. Thirdly, as anybody who knows sixth-form time-tables must be aware, it is unrealistic to expect more than two or three periods a week for such a course, and the time must be carefully used. If the boys have not done any practical biology at an earlier stage—and I should agree with Prof. Cannon in deploring this—it is useless to start here, and unlikely to impress them with the importance of the subject. Of course, one cannot deal exhaustively with the many applications of biology to human affairs in the time available; but one can, as I have shown in practice, arouse interest in the work of biologists which bears on social problems, indicate the kind of answers they would give, and send the boys out keen enough to follow up the work by reading for themselves, and free from some of the superstitions and prejudices with which otherwise reasonable people sometimes approach psychology, heredity, evolution, the birth-rate, intelligence-tests and so on.

Prof. Cannon attacks my course first on the ground that it covers too large a field, and then objects strongly to the idea of selecting some aspects for more detailed treatment than others. The idea that the interests of the class should be a guide as to which problems one pursues comes as a novelty to him, apparently, as in his opinion the order of the course (as laid down by T. H. Huxley, significantly!) must not be disturbed. Later in his review it becomes clear that his eyes are really on examinations rather than education, and, of course, the need to adhere rigidly to a given syllabus is one of the few major drawbacks to an examination system.

The criticism that a course of biology should be based on adequate practical work, natural history and comparative anatomy and embryology is, of course, unanswerable when the biology students, with whom Prof. Cannon deals, are under consideration; but completely impracticable for the history and classical scholars with whom, one suspects, he has very little contact. A good deal can be done by demonstration; they are shown the chromosomes, and the look of an F_2 generation of *Drosophila*, or plankton samples, and they value the experience. But to ask that they should learn the technique of *Drosophila* culture, or that they should be provided with microscopes and personally record the various links in the food-chain of the herring, is unrealistic for the non-specialist.

I should also deny that a course of this kind encourages boys to learn "whole passages or whole problems by heart on the chance of getting a question on them in the examination". In practice it is designed to make them think, and relate theoretical and applied biology to the problems of their time and to their other school subjects. I do not, of course, claim that my outline syllabus is the only answer, or necessarily the right one. It is the result of only fourteen years of experiment in one school. But I am sure that something of the sort is well worth while, and that professors of any of the biological sciences could help by making constructive suggestions as to what scientific ideas the future Civil Servants, lawyers, industrial leaders or clergy of Great Britain should be made aware of. It must be remembered that most of these will come from the sixth forms of our grammar schools, and that for many of them a course of this kind will be the last formal science teaching they will receive. Prof. Cannon does not, however, make constructive proposals.

The accusation that there is too much emphasis on what Prof. Cannon calls 'Neo-Mendelism' is based on a misreading of my paper. The second term's work is not "devoted very largely to a study of Mendelism", but centres on evolution, and embraces also the study of population growth, variation and environmental influences and extinction. When Prof. Cannon writes, of Mendelism, "It is easy to teach, what is certain", I leave it to those who have experience of teaching even highly intelligent non-specialists to judge whether my course or Prof. Cannon's review is the more 'fantastic'.

ERIC LUCAS

The College,
Winchester.
April 25.

MR. LUCAS in his original pamphlet is emphatic that his proposed syllabus is for sixth-form boys specializing in classics, history, mathematics: in fact, in anything other than natural science. Now in the third paragraph of his letter above, he says that if these boys have "not done any practical biology at an earlier stage . . . it is useless to start here". I can only take this to mean that unless these arts students have done some elementary biology in their earlier years at school and so done some *practical* biology, his syllabus for the course of study at the sixth-form level is useless. Is he assuming, therefore, that in these enlightened days all boys, whatever subject they may ultimately specialize in, have had a groundwork in the elements of biology in their early school days ? This may be so at Winchester ; but does he not know that, in the greater number of secondary grammar schools in which biology is taught at all, it is only taught on the science side, and in many of these schools is only dealt with in the sixth form ? His pamphlet, as I pointed out, "purports to deal with the way in which biology and social biology at that can be introduced to a sixth form who have done no biology before"—not the sixth form of any particular school but presumably at any secondary grammar school. That is the way in which I maintain his pamphlet will be interpreted and that is why I criticize it.

But also perhaps I have been guilty of inaccuracy in my review because Mr. Lucas seems to have deduced that I would insist on practical work in the type of biology course he is considering. I did not, however, say this. I merely pointed out that a university professor had the advantage of adequate time for practical work guided by a bevy of demonstrators. If time is short (and nobody disputes this as regards Mr. Lucas's course) then practical work is the last thing I should insist upon. Why, almost as much time can be wasted over practical work in biology as over field-work in botany ! By all means have as many demonstrations as possible, as Mr. Lucas suggests, but heaven forbid that I should ever be called upon to demonstrate an F_2 generation of *Drosophila* to any class, sixth form or otherwise, let alone teach these same boys how to culture the annoying little creatures. No, if I had two periods a week for one year at my disposal and an intelligent sixth form, then, always remembering that the boys had done no biology before and also that the time must be carefully used and not frittered away in snippets here and snippets there, I feel that I could use that time profitably by talking about the *elementary* facts of biology—giving the students some idea of what an organism is, particularly what a human organism is and its relation to its surroundings. This would then enable these boys later on to develop their ideas on these foundations, to ask themselves and others questions that were of importance and not mere trivialities. Mr. Lucas says that his sixth-form boys "want to put the questions to a biologist that an adult would ask". They may want to : but are they equipped to do so ? When they have been given the foundations of the subject they certainly can, if they are intelligent, ask valuable questions ; but until then it will be more by luck than judgment if they manage to avoid the type of inanity with which we are so familiar in our first-year students—and, after all, our first-year students are only glorified sixth-formers. That is why, by the way, I may not be so unfamiliar with the type of student that Mr. Lucas deals with as he appears to imagine.

Then he reproaches me with having an eye on examinations—but why not ? I have had plenty of experience of how schools *do* cater for examinations—especially those for open university scholarships. We all know of the irrational scramble for scholarships among schools, and this all involves catering for examinations : so why not assume that this sixth-form 'culture' is encouraged with one eye on the examinations ? What about this general knowledge paper which it is proposed to introduce into the new examination ? Mr. Lucas's syllabus is just the sort of thing for this paper : and who suggested it ?—Was it the schools or the examining boards ? It was certainly not the latter in this part of the country.

Finally, I am sorry that Mr. Lucas finds genetics a difficult subject to teach. I can only repeat what I said at the meeting of the British Association at Brighton last year, referring to this aspect of biology, "despite the profundities of the Neo-Mendelians, it is still possible to deal with this matter adequately in a few lectures".

But why should Mr. Lucas worry over such a trifle ? As his original pamphlet points out—if a subject is too difficult for the student or the teacher, just drop it and go on to something more entertaining.

H. GRAHAM CANNON

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INELASTIC SCATTERING OF PROTONS BY MAGNESIUM AND ALUMINIUM

By E. H. RHODERICK
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THE inelastic scattering of protons by some light elements has been investigated experimentally, using 4·5-MeV. protons from the Cambridge cyclotron. The energy spectrum of the scattered protons was determined by using a proportional counter in conjunction with absorbing foils. The experimental arrangement was similar to that used by Dicke and Marshall[1], except that provision was made for observation of the scattered protons at angles between 20° and 160° at 10° intervals. Only proton groups corresponding to excited states less than 2·5 MeV. above the ground-state were able to reach the counter. The resolving power was improved by a factor of four over that obtained by Dicke and Marshall by the simple expedient of rotating the scattering foil through 90° from the position adopted by them, which minimizes the effect of target thickness. Under these conditions the resolving power was about 250 keV. for inelastic groups of equal amplitude.

The spectrum of the protons scattered by magnesium is shown in Fig. 1. The first inelastic group corresponds to a Q value of $-1\cdot36 \pm 0\cdot03$ MeV., and in view of its large amplitude is almost certainly associated with the predominant isotope, magnesium-24. The excited state of the residual nucleus which is involved is probably that which is responsible for the 1·38-MeV. gamma-ray emitted following the beta-decay of sodium-24, which has been measured very accurately by Siegbahn[2]. The Q value of this group remained constant with angle to within ± 0·015 MeV., which represents the relative error in the measurements at different angles. The second inelastic group corresponds to an excited state 1·82 ± 0·04 MeV. above the ground-state, and in view of its small amplitude may belong to an isotope other than magnesium-24. The presence of an inelastic group at this energy has recently been confirmed by Bush and Fulbright[3], though these authors state that its amplitude is comparable with that of the first inelastic group for higher bombarding energy.

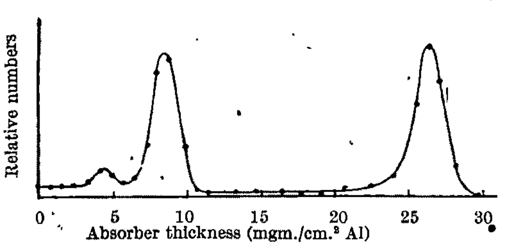

Fig. 1. Spectrum of protons scattered through 110° by magnesium (incident proton energy = 4·73 MeV.)

The spectra of the protons scattered through three different angles by aluminium are shown in Fig. 2, from which it is seen that the first inelastic group has a complex structure. At 90° the peak is nearly resolved into two groups, and can be well explained by the existence of excited states in aluminium-27 respectively 0·80 and 0·97 MeV. above the ground-state. The shape of the peak varies considerably with angle, and in general is too indefinite to admi of such a precise interpretation as that given at 90° though the left-hand component seems fairly wel established at 0·97 ± 0·02 MeV. All that can be said with certainty is that this level is accompanied by at least one other level lying above 0·75 MeV The second inelastic group was able to reach the counter only for scattering angles less than 90°, and corresponds to an excitation energy of 2·15 ± 0·05 MeV. There is little correlation between the excited states of aluminium-27 obtained in this way and existing information[4] on the gamma-rays which follow the beta-decay of magnesium-27.

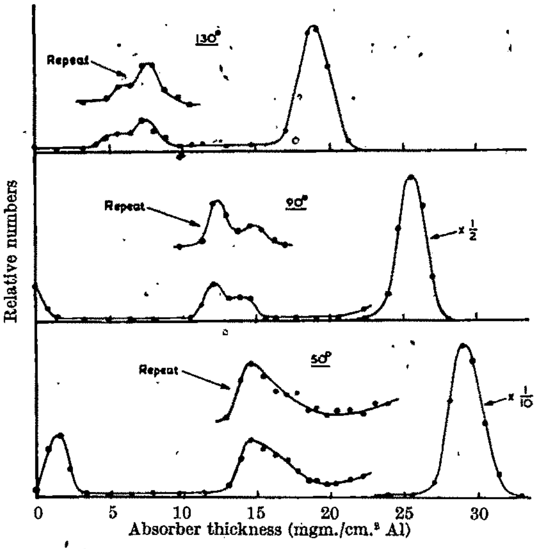

Fig. 2. Spectra of protons scattered by aluminium (incident proton energy = 4·56 MeV.). The vertical scale is not necessarily the same at all angles

The first inelastic group from magnesium is considerably larger than that from aluminium, and has a very different excitation function. The former increases sixfold on raising the incident proton energy from 4·2 to 4·7 MeV., whereas the latter is almost independent of energy in this region. This can be understood in terms of penetration of the potential barrier by the outgoing proton, since, in the case of aluminium, the proton emitted has almost enough energy to pass over the top of the barrier at the lowest bombarding energy used. This suggests that at these bombarding energies the reaction is predominantly a (p, p) process involving formation of a compound nucleus, which is interesting in view of suggestions[5,6] that nuclear excitation might be effected by Coulomb interaction. The total cross-section for excitation of magnesium to the 1·38-MeV. state by 4·73-MeV. protons is about 8×10^{-25} cm.² (assuming it to be associated with magnesium-24), while that for excitation of aluminium to the 0·97-MeV. state by 4·4-MeV. protons is about $1 \cdot 2 \times 10^{-25}$ cm.^{2}. These figures were estimated by an indirect method, and are reliable only to within about 30 per cent.

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* Now at the Department of Natural Philosophy, University of Edinburgh.

The scattering of protons by beryllium was also investigated briefly, and an inelastic group observed corresponding to an excited state 2·39 ± 0·05 MeV. above the ground-state, in agreement with the results of Davis and Hafner[7]. This state is unstable with regard to neutron emission. No inelastic groups were observed from carbon, oxygen or copper.

I would like to thank Dr. A. E. Kempton and Mr. L. Coates for assistance in the experiments.

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MOLECULAR WEIGHT DETERMINATION ON THYMONUCLEIC ACID COMPOUNDS BY DIELECTRIC MEASUREMENTS

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AND
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Sodium Thymonucleate

THE molecular weight of a thread molecule with a permanent dipole moment such as desoxyribose nucleic acid can be calculated from the anomalous dispersion of the dielectric constant. By the so-called ellipsoid method[1] sodium thymonucleate was shown to have an extremely high dielectric increment, and the molecular weight was found to be very low (only about 16,000). This value, which was obtained only from measurements in 0·1 per cent aqueous solution, has since been found erroneous. In any event, it is quite clear that the dielectric method gives considerably lower values than those obtained by the ultracentrifuge, diffusion or streaming birefringence methods (200,000–1,500,000)[2-4].

In continuing the investigations the ellipsoid method was considerably improved and attained a considerable degree of exactness, and was especially adapted to the unexpectedly high frequencies needed for desoxyribose nucleic acid. Fig. 1 shows examples of some anomalous dispersion curves of the sodium salt of the acid (prepared according to Hammarsten[5]) at different concentrations. The arrows indicate the inflexion points (critical wave-lengths), and the broken curves are the theoretical dispersion curves according to Debye. The smaller graph shows the dielectric increments at different concentrations and at a wave-length of 1,000 metres (0·3 Mc./s.).

The new measurements with 0·1 per cent solution agree well with those previously obtained, except at the highest frequencies, where the earlier results were misleading. Nevertheless, there still occurs a small but constant deviation from the theoretical curve according to Debye (see graph). This deviation can be explained by association, but it indicates that the 'molecular weight' thus obtained is not a true one.

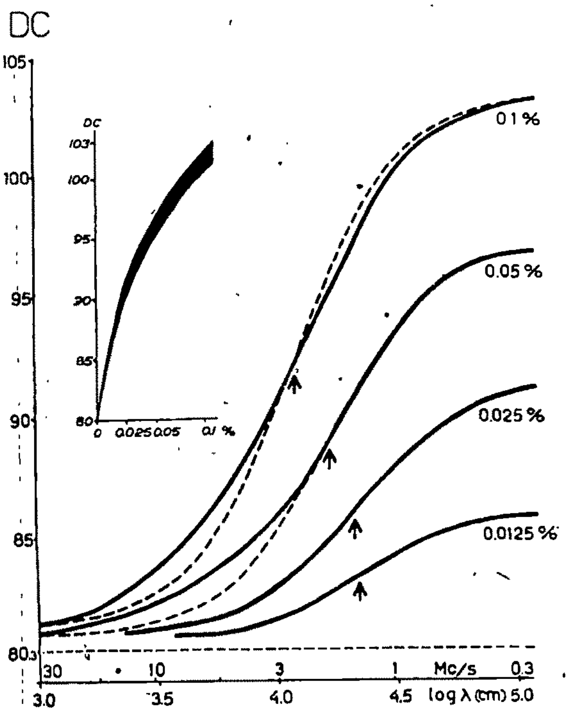

Fig. 1. Anomalous dispersion curves of sodium desoxyribose nucleate at different concentrations. Temperature 20° C. Concentrations in gm. of air-dried substance (moisture content 22·1 per cent) per 100-ml. solution

An attempt to reduce the amount of association by measuring in even more diluted solutions revealed an unexpected effect, namely, that the apparent 'molecular weight' increased with the degree of dilution. This is evident from Fig. 1, which shows that the inflexion point advances towards longer wave-lengths. The reason for this advance is not clear, but we assume that in less dilute solutions a structure is formed (by non-polar association; cf. the smaller graph). In such a structure, the larger aggregates would be impeded in their orientation in the alternating field, and the polarization would be more dependent on smaller and easily movable parts. In very dilute solutions (less than 0·03 per cent) the experimental and theoretical dispersion curves coincide, the critical wave-length is nearly constant, and a dielectrically uniform molecular weight of about 135,000 is obtained.

The high tendency to association led us to doubt whether the new value of about 135,000 was a true molecular weight. It has now also been shown that the 'molecular weight' readily changes, for example, on the addition of small quantities of salts. The effect is completely reversible. It is remarkable, however, that only insignificant additions are needed for the 'molecular weight' to fall, and at a concentration of 0·002 *M* sodium chloride we get approximately 35,000. We have not been able to get lower values. Difficulties due to the method itself prevent measurements in strong salt solutions, and other treatments of desoxyribose nucleic acid (heating, X-ray, etc.) are not reversible. Almost the same value, 33,000, was found by Hammarsten[6] by direct osmotic measurements on sodium thymonucleate in liquid phenol.

The molecule of 35,000 has a quarter of the dipole moment of the 135,000 compound. Thus it is a pure polar association in very dilute aqueous solutions, and the aggregates are built up in exactly the same manner from a dielectric point of view as is assumed for the lower components. Obviously it is necessary to discriminate between *polymerization* and polar (probably end-to-end) *association*. In connexion with aggregates which can so easily be changed that they cannot even exist intact in solutions far below physiological salt concentration, it seems convenient to use the term *association*. *Polymerized* aggregates, on the other hand, will then be decidedly more resistant molecules. The observed value, about 35,000, is then to be regarded as the highest probable molecular weight for the sodium thymonucleate molecule.

The great tendency for desoxyribose nucleic acid to associate seems to be important for the investigation of enzymatic digestion; this should be noted, so that the easy disaggregation may not be mistaken for a depolymerization.

Nucleohistone from Calf Thymus

We have now begun investigations on desoxyribose nucleic acid nucleoproteins, and in the first place nucleohistone. Carter and Hall have made a preparation from calf thymus[7], which has been thoroughly investigated physico-chemically[8,9]. They found the nucleohistone to be monodisperse and to have a molecular weight of about 2,000,000, determined by means of measurements of sedimentation and diffusion. The axial ratio was 35.

We have made five preparations according to Carter and Hall and two others according to Stern[10]. No significant difference in respect of dielectric properties was observed. The chemical composition varied somewhat, and from the results of the analyses a desoxyribose nucleic acid content varying between 42 and 45 per cent was calculated.

Examples of some anomalous dispersion curves of nucleohistone at different concentrations are given in Fig. 2, where the inset graph shows the increments of the dielectric constant at different concentrations and a wave-length of 1,000 metres.

As appears from Fig. 2, the dispersion curves of nucleohistone exhibit the same dependence on concentration as was previously established for sodium thymonucleate (see above). We do not think that this effect can be chiefly due to a change of ion activity or solvation. We assume rather that, as in the case of desoxyribose nucleic acid, it is connected with a structural formation in more concentrated solutions, so that the individual molecule is prevented from orientating itself freely in the electric field.

Calculations of dipole moment and molecular weight were made at the lowest concentrations (less than 0·1 per cent), where the increment rises linearly with the concentration (Fig. 2, inset). The dipole moment calculated according to Debye is then 65×10^{-18} E.S.U. The molecular weight for different preparations varies between 65,000 and 80,000, with a value of about 75,000 as most probable. The content of desoxyribose nucleic acid calculated then corresponds to a molecular weight for that component of about 35,000. This value shows an interesting agreement with our presumed highest conceivable molecular weight for sodium thymonucleate and tha found by Hammarsten[6]. It also indicates that th high molecular weights which will be found fo desoxyribose nucleic acid in dilute aqueous solutions and which are very easily affected by salts, are no true molecular weights.

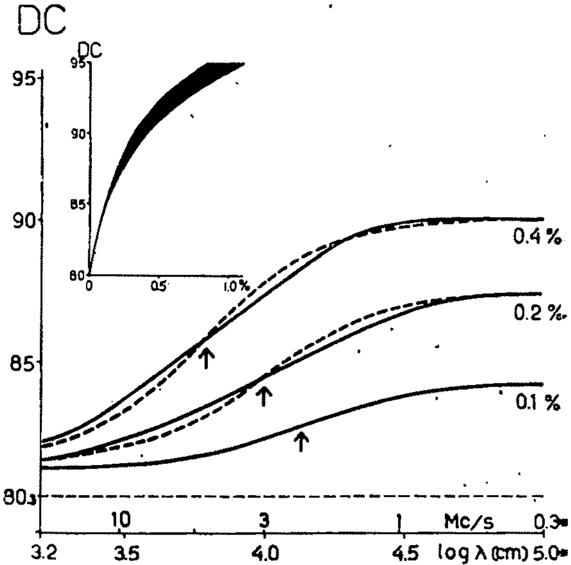

Fig. 2. Anomalous dispersion curves of nucleohistone at different concentrations. Temperature 20° C. Concentrations in gm. of air-dried substance (moisture content 11·7 per cent) per 100-ml. solution

As in the case of desoxyribose nucleic acid, th molecular weight of nucleohistone decreases considerably in salt solutions (about 25 per cent i 0·0004 *M* potassium chloride). The effect is completely reversible, also, by treatment with stronge salt solutions (for example, 1 *M* sodium chloride fo several days). This decrease in molecular weight however, differs from that caused by the influence o salt on desoxyribose nucleic acid in the appearanc of a relatively high content of low molecular parts We think, therefore, that the decrease is due to partial dissociation of the nucleohistone, which doe not necessarily influence the magnitude of th desoxyribose nucleic acid component. Unlike desoxyribose nucleic acid, the molecular weight is no changed in urea solutions.

It has recently been suggested that the nucleohistone prepared according to Carter and Hal probably suffered considerable degradation[11]. Fo this investigation, however, the important point i that the dielectric method gives a considerably lowe value of the molecular weight for this preparation of nucleohistone, as well as for sodium desoxyribos nucleate, than that obtained by other methods.

---

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FULMER RESEARCH INSTITUTE

ANNUAL REPORT FOR 1947–48

THE Fulmer Research Institute, opened in July 1947, is similar in constitution to the Battelle and Mellon Institutes; its first annual report includes a brief description of the main departments —chemistry, physics and engineering, metallurgy, heat treatment—and of their more important equipment. During the eighteen months under review, the staff increased from forty-five to sixty-five, and sixteen workers with university degrees or equivalent qualifications and sponsors' nominees are now engaged in the laboratories under the director of research, Mr. E. A. C. Liddiard. The scientific staff is headed by Dr. P. Gross and Dr. A. H. Sully.

Only a general account of work in progress is given in the report. The team working under Dr. Gross has been mainly concerned with further studies of the reaction between metallic aluminium and aluminium trichloride vapour at 900–1,000° C. and at a few mm. of mercury pressure to give aluminium monochloride, AlCl. The vapour thus formed decomposes again on cooling into the trichloride and aluminium, and the reaction is expected to provide the basis of a new process for extracting and refining aluminium by 'catalytic distillation'. A semi-technical plant is under construction, and the process may possibly permit the extraction of aluminium by carbo-thermic reduction of low-grade ores. Experiments on the possibility of refining other metals by a similar technique indicate that silicon, boron and nickel can be distilled in this way.

An investigation is also in hand to develop materials with improved properties at high temperatures, particularly chromium-base alloys, and for this purpose a high-frequency generator and furnace have been constructed. Machines have also been designed and constructed in the laboratory workshops for measuring the creep of alloys in tension and in compression up to 1,000° C., and have given results of surprising accuracy. Pure alumina crucibles and other shapes have been made by slip casting and firing in the laboratories, and in view of the good service obtained, research has been extended to the refractories field. The recrystallization of refractory oxides is being studied by X-ray diffraction, and a comprehensive investigation is being made of the mechanism of precipitation in high-purity aluminium–copper alloys, with particular reference to the effects of third elements on lattice spacing. The constitution of aluminium–tin alloys has been studied with particular reference to the solid solubility of tin in aluminium and to the effects of tin on mechanical and physical properties, casting characteristics and hardening by precipitation. The properties of fluxes used in remelting aluminium cuttings and turnings are being investigated with the object of increasing their efficiency in preventing oxidation and decreasing metal losses, and a comprehensive investigation on the corrosion of aluminium alloys used in buildings is in progress. The causes and prevention of blisters and similar defects in plated aluminium articles are being studied, and various problems associated with the development of high-speed knitting machines have been solved.

Some 138 inquiries, some outside the field of light alloys or metallurgy, were dealt with in the period. A list of published notes and papers is appended, together with the names of sponsors and a list of staff.

GLASSHOUSE RESEARCH

THE annual report of the Experimental and Research Station at Cheshunt always sets forth a crop of useful results; but the latest one, which is for 1947 (the Station, Turner's Hill, Cheshunt, Herts; 1948), provides the answers to many questions on glasshouse culture. J. Littlewood and O. Owen publish the results of extensive experiments on the relation between the amounts of plant nutrients in the soil and those in the plant, with particular reference to methods of soil extraction used in advisory analyses. They conclude that extractions for potash with $N/2$ acetic acid, and for phosphoric acid with distilled water, give the most practically useful results. This is important; but even more urgent is their insistence on the determination of total nitrogen for advisory purposes, and it is impossible not to agree most strongly with this conclusion. O. Owen and G. W. Winsor have also studied in detail the question of nitrification in glasshouse soils. Farmyard manure is now scarce, and O. Owen has a useful paper on the use of sodium alginate as a substitute for it in tomato composts. The preliminary trials show that it is quite satisfactory.

The tomato moth, *Diataraxia oleracea*, causes serious injury in some commercial glasshouses. A very detailed paper by E. R. Speyer and W. J. Parr assesses its economic importance, describes the various stages of its life-history, and reviews methods for control. The pest was responsible for an annual loss of crop worth £30,000 in the Lea Valley in 1918, was later controlled to negligible proportions as a result of Lloyd's advice to spray with lead arsenate, and again assumed serious proportions following war-time changes in cropping. D.D.T. can now be used successfully against this insect; but the paper also discusses the value of other substances and methods for control. The uses of insecticides for other particular purposes are described by W. H. Read. Azobenzene fumigant and petroleum emulsions provide about equal control of red spider, and the use of hexaethyltetraphosphate is promising.

Didymella stem rot is a serious trouble. It is shown by P. H. Williams to be more severe when nitrogen is in excess in the soil, and its spores can withstand freezing temperatures. W. H. Read has tried treatment with ethyl mercury phosphate; but this does not, as yet, provide a hopeful means of control. R. Howles shows, *inter alia*, that tomato plants kept turgid by the provision of adequate water had less severe virus symptoms than when less water is given. The control of soil pathogens by means of antibiotic substances is a fascinating possibility, and E. Grossbard has found that *Penicillium patulum* will produce a growth-inhibiting substance when cultured on sugar-beet pulp or straw with glucose. The substance is antibiotic to several organisms, including *Bacillus carotovorus*, *B. phytophthorum*, *Phytophthora parasitica* and *P. cryptogea*.

More general investigations, under the control of Dr. W. F. Bewley, director of the Station, include a comparison of sterilizing by steam and by formaldehyde, the use of straw between rows, the effect of withholding lime and phosphate, the usual variety trials, and experiments on watering. These have all yielded results suitable for immediate practical application, and represent the delivery of the digested work of the Station to the industry it serves so well.

J. GRAINGER

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, May 31

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. A. V. Hill, F.R.S.: "Muscular Contraction".* (Further Lectures on June 7 and June 14.)

INSTITUT FRANÇAIS (at Queensberry Way, London, S.W.7), at 6 p.m.—M. Paul Couderc: "Astronomie nouvelle".*

Wednesday, June 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Edwin H. Land: "Optical, Polarisers".

Thursday, June 2

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. J. S. Bach: "Some Aspects of Nitrogen Metabolism in the Mammal".* (Further Lectures on June 9, 16 and 23.)

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. E. H. Land: "A Colour Translating Ultra-Violet Microscope" (Twenty-sixth Duddell Lecture). (Members of the Optical Group are invited.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICIST IN THE PHYSICS DEPARTMENT—The Secretary, Westminster Hospital, St. John's Gardens, London, S.W.1 (June 3).

LECTURER IN MATHEMATICS at the Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (June 4).

LECTURER IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford (June 4).

LECTURER IN BIOLOGY to teach botany and zoology up to Intermediate B.Sc. standard—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (June 4).

SENIOR LECTURER IN GEOGRAPHY (up to Final Degree standard with special reference to Economic and Political Geography) at the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton (June 4).

LECTURERS IN SCIENCE, and a LECTURER IN MATHEMATICS, at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2564 (June 9).

SENIOR ASSISTANT IN MATHEMATICS at the Leeds College of Technology—The Director of Education, Education Department, Leeds 1 (June 11).

EDITOR of the "British Pharmaceutical Codex", "Extra Pharmacopoeia" and other scientific publications—The Secretary and Registrar, Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, London, W.C.1 (June 11).

HISTOLOGIST to collaborate in researches on endocrinology of lactation and reproduction and other research projects involving histological studies—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (June 11).

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS, for work on the physics of metals in Ministry of Supply Research and Development Establishments in London and S. England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1190/48A (June 11).

PROFESSOR OF GEOLOGY, and LECTURERS IN GEOGRAPHY, BOTANY, MARINE ZOOLOGY, ORGANIC CHEMISTRY, and GEOLOGY, in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 13).

CHAIR OF APPLIED MATHEMATICS, THE CHAIR OF EDUCATION, THE CHAIR OF HISTORY, a LECTURER IN PHYSICS, and a LECTURER IN SOCIAL STUDIES, at Raffles College (University of Malaya), Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 13).

DEMONSTRATOR OF BIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (June 15).

LECTURER (Grade II) IN APPLIED MATHEMATICS—The Secretary and Registrar, The University, Bristol (June 17).

SENIOR LECTURER or LECTURER, and an ASSISTANT LECTURER, IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (June 17).

PHYSICIST to the Regional Radium Institute—The Secretary, Bradford 'A' Group Hospitals Management Committee, Royal Infirmary, Bradford (June 18).

ASSISTANT MASTERS (with a degree or equivalent qualification in Mathematics, Physics, Mechanical or Electrical Engineering) in H.M. Dockyard Schools at Portsmouth, Devonport, Chatham, Sheerness and Rosyth—The Director (P.A.), Education Department, Admiralty, London, S.W.1 (June 18).

SEAGOING OBSERVERS (with a good general science background up to at least Intermediate B.Sc. standard in chemistry, physics and one other subject, preferably biology) on distant-water trawlers—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.333/49A (June 20).

DIRECTOR of the Laboratory Animals Bureau and SECRETARY of the Council's Advisory Committee on the Supply of Laboratory Animals—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1 (June 20).

LECTURER IN PURE MATHEMATICS—The Registrar, King's Colleg Strand, London, W.C.2 (June 24).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (June 25).

NATURALIST at the Dove Marine Laboratory—The Registra King's College, Newcastle-upon-Tyne (June 25).

ASSISTANT KEEPER (Biology, with special knowledge of botany and an ASSISTANT KEEPER (Geology, with special knowledge palæontology)—The Director, Museum and Art Gallery, Leicest (June 25).

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY—The Registra The University, Leeds 2 (June 25).

PLANT PHYSIOLOGIST and a PLANT BREEDER (Junior Professiona Officers grade) in the Tobacco Division, Department of Agricultur Southern Rhodesia—The Secretary to the High Commissioner f Southern Rhodesia, 429 Strand, London, W.C.2 (June 30).

KEEPER OF THE DEPARTMENT OF GEOLOGY, a KEEPER OF TH DEPARTMENT OF ETHNOLOGY, and an ASSISTANT KEEPER IN ARCHÆOLOGY AND ETHNOLOGY, in the Liverpool Museums Department—The Town Clerk, Municipal Buildings, Liverpool 2 (June 30).

PRINCIPAL SCIENTIFIC OFFICER under the Ministry of Supply fo technical administration and organisation of research work in physics metallurgy carried out in academic, industrial and Government laboratories in connexion with aircraft metals and alloys—The Minist of Labour and National Service, Technical and Scientific Register (K York House, Kingsway, London, W.C.2, quoting F.332/49A (June 30

ASSISTANT KEEPER to be responsible for the Zoological Collectio in the Manchester Museum—The Registrar, The University, Manchester 13 (July 1).

PRINCIPAL SCIENTIFIC OFFICER for supervision of all aspects, research and development in Helicopters from project stage to completion of tests on experimental types, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientifi Register (K), York House, Kingsway, London, W.C.2, quotin C.303/49A (July 2).

PROFESSOR OF THEORETICAL PHYSICS—The Registrar, India Association for the Cultivation of Science, Calcutta 12, India (July 15

LECTURER IN MATHEMATICS, a LECTURER IN METALLURGY, and LECTURER IN CHARGE OF GENERAL AND ADULT STUDIES, at the Wolverhampton and Staffordshire Technical College—The Clerk to the Join Education Committee, Education Offices, North Street, Wolverhampton.

SENIOR INSPECTOR, and INSPECTORS (2), under the Seed Productio Committee—The Secretary, National Institute of Agricultural Botany Huntingdon Road, Cambridge.

LECTURERS or ASSISTANT LECTURERS (2) IN CIVIL or MECHANICA ENGINEERING, and a LECTURER or ASSISTANT LECTURER I METALLURGY—The Registrar, The University, Nottingham.

CARTOGRAPHERS in the War Department Map Production Establishment—The Survey Production Centre, R.E., 309 Elveden Road London, N.W.10.

LECTURERS (2) IN THE DEPARTMENT OF MATHEMATICS—The Directo of Studies, Royal Naval College, Greenwich, London, S.E.10.

LECTURER IN STATISTICS—The Registrar, The University, Reading

METALLURGIST in the laboratory at Derby—The Scientific Researc Manager, Railway Executive (London Midland Region), Eusto Station, London, N.W.1.

LECTURER IN PHYSICS to Special B.Sc. standard—The Principal West Ham Municipal College, Romford Road, Stratford, London E.15.

LECTURER IN THE DEPARTMENT OF METALLURGY, and a GEOGRAPH MASTER, at the County Technical College, Wednesbury—The Directo of Education, County Education Offices, Stafford.

PHYSICAL CHEMIST with some research experience—The Secretary British Rayon Research Association, 58 Whitworth Street, Manchester

PROFESSOR OF EXPERIMENTAL PHYSICS—The Registrar, Universit of Manitoba, Winnipeg, Canada.

RESEARCH ASSISTANT (graduate in Physiology or Zoology) to joi group investigating biological effects of radioactive substances—Dr. Janet Vaughan, Department of Pharmacology, Oxford.

MUSEUM TECHNICAL INSTRUCTOR by the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quotin M.N.22382/3E.

LABORATORY ASSISTANT—The Headmaster, Hackney Downs School Downs Park Road, London. E.5.

HISTOLOGICAL TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Secretary, St. Mary's Hospital Medical School, Paddington London, W.2.

LECTURER IN BIOLOGY—The Principal, Royal Technical College, Salford 5.

MECHANICAL ENGINEER for experimental investigation of stresses in motor vehicle components, and an ELECTRICAL ENGINEER o PHYSICIST for research and development work on the application o electronic methods to mechanical engineering problems—The Director Motor Industry Research Association, Great West Road, Brentford Middx.

RESEARCH OFFICERS (2) for fundamental research in chemica problems connected with the manufacture of gelatine and glue—The Director, British Gelatine and Glue Research Association, Sardinia House, 52 Lincoln's Inn Fields, London, W.C.2.

ASSISTANT or ASSOCIATE PROFESSOR OF ORGANIC CHEMISTRY—The Secretary, Department of Chemistry, University of Britis Columbia, Vancouver, Canada,

HEAD OF THE DEPARTMENT OF PHYSIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

TEA RESEARCH OFFICER in Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

TIMBER INVESTIGATIONS OFFICER for the Forestry Department, Government of Sierra Leone—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.22155/3E.

HONOURS GRADUATE, with first-class basic training in Chemistry or Biochemistry (or Chemical Engineering or Agricultural Chemistry), for training as a Fish Processing Expert—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

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NATIONAL PARKS IN BRITAIN

WHILE the National Parks Bill received an unopposed second reading in the House of Commons, the course of the debate indicated that some modification might be expected at the committee stage. Dr. Hugh Dalton, indeed, on April 1 went so far as to suggest that members who had ideas on the functions of the commission or the planning authority or any other matters that had been discussed might possibly find their ideas accepted, perhaps in modified form, during the committee stage. There may well be a brisk response to this encouraging, if unusual, pronouncement, though it may be a matter of opinion whether the two most important points on which criticism fastened—the composition of the park planning authorities and the powers of the National Parks Commission—are really committee points as Mr. Dalton suggested.

The Bill makes the National Parks Commission responsible for the preservation and enhancement of natural beauty in England and Wales, and particularly in the areas to be designated under the Act as national parks or as areas of outstanding natural beauty, and for encouraging the provision or improvement of facilities for enjoying the national parks and the opportunities the parks afford for open-air recreation and the study of Nature. Nevertheless, the Commission is to be wholly advisory, and there appears to be no provision for making its advice effective or even to ensure that local authorities act on its recommendations; further, as Sir Arthur Salter pointed out, the Commission is to be advisory in matters upon which it is most unlikely that its advice would prevail against contrary interests.

The full significance of this weakness is o[illegible] apparent when it is realized that the administra[illegible]on of the national parks and execution of the proposals of the National Parks Commission is to be entrusted to the local authorities, either to the planning board of a single authority, or to a joint board where the area of the proposed park falls into several counties. If the Minister decides to dispense with a joint board, the local planning authorities concerned must have a separate committee to deal with any land in their area which is within the boundaries of the park. At least one quarter of the members of the joint boards, advisory committees or special committees appointed for the purpose must be appointed from persons nominated by the Minister after consultation with the Commission. The preparation of development plans for an area including any part of a national park is to be the responsibility of the local planning authorities, who are to be allowed one year after a national park order made by the Commission comes into effect to formulate proposals, which they must discuss with the National Parks Commission.

Such procedure does not warrant optimism that national parks will come into being at an early date. Moreover, the urgency of the problem arises largely, if not primarily, from the action of Government departments which, as was stressed on all sides in the debate, neither the National Parks Commission nor the local authorities will have powers to resist. This, however, as the Hobhouse Committee insisted, is the major threat to national parks in Britain, and its reality has been emphasized by what has been happening in regard to Dartmoor and other areas while the Bill has been under debate. There is no confidence, indeed, in the ability of the Minister of Town and Country Planning to resist such pressure. Mr. Dalton's statement in the debate that something like what is proposed in the Hobhouse Report, namely, the submission of matters in dispute to a permanent group of Ministers, is already the practice, might have been better received if the evidence were more convincing that Service departments are not allowed to be judges in their own cause.

In view of Mr. Dalton's statement that an inter-departmental committee of senior ministers is already operative, it is difficult to understand the reluctance of the Government to adopt openly a recommendation which would go far to restore confidence in the genuineness of its support for national parks. As it is, Mr. Silkin, in addressing a meeting of the Ramblers' Association on April 10, still burked the plain fact that if the conservation of Nature and of natural beauty is to mean anything, at some point a National Parks Commission or an inter-departmental committee of Ministers must have the right to over-rule a particular ministry. The Government itself apparently refuses to recognize the implications of the conflicting demands of so many kinds, all based on genuine national interest, for our limited resources of land; and the failure to co-ordinate, in particular, the Services demands for training areas exacerbates a public opinion which, although it fully recognizes the vital importance of setting aside a proper proportion of land for that purpose, rightly declines to admit that each particular demand can be discussed [illegible] isolation or without regard to other national interests.

The whole point of the argument for national parks is that there are some areas in which the claims of amenity and of natural beauty must come first; even such a vital interest as defence cannot come first all the time, or there will be nothing left to defend. It could be wished that, in introducing the Bill, Mr. Silkin had shown more clearly that he recognizes amenity or natural beauty as a national need and a public interest, and that its claims have to be weighed along with other public interests—the need for food, for water, for electric power, minerals, military training and the rest. In conservation areas its claims must be given more than the usual weight: in national parks they must preponderate and only be over-ruled in some grave and dire emergency.

Some encouragement may be drawn here, however, from Mr. Silkin's reference to a wider function of the Commission which goes beyond the recommendations of the Hobhouse Committee. The Commission is to be responsible generally for directing attention to any question affecting natural beauty in any part of England and Wales, and will also be responsible for selecting the other areas of natural beauty to which special powers are to apply. These areas will normally be smaller in extent than the national parks and, for that, or some other reason, therefore unsuitable for designation as national parks. That function can be adequately discharged unless there is full harmo of purpose between the Commission and the plann committees to whom the executive powers are to entrusted. If the parks are administered by jo boards or, in the single-county areas, by the spe committees to which Mr. Silkin referred, it is impossible that, in the hands of men and women w care deeply for the purposes the Bill purports serve, we may see real national parks and merely local authority parks. What should remembered is that the proposed composition of joint planning boards or special committees place heavy strain on the loyalties of the members appoin by the local authorities—a strain that could reaso ably be argued as invidious.

While that contention finds some support in wh for example, has been manifested already in lo council elections in the Lake District, it should still remembered that the main threat to the preservati of natural beauty comes from public authoriti whether they are local or central. The National Pa Bill does, indeed, provide the means for the claims natural beauty to be advanced as a public intere Whether representations will be effective agai claims of other public interests, both local a central, appears to depend less on the organisati established by the Bill than on our ability administer its provisions with the determination a imagination which will realize the capacities for go which are undoubtedly inherent in the Bill.

Nowhere is this more apparent than in regard the further duty to be laid on the Commission selecting the long-distance footpaths. That duty complementary to the duty placed on the coun councils of conducting within three years a surv of all the public paths in their area, and preparing draft map showing existing footpaths or bridle-wa Some county councils, such as those of Essex, Ham shire and West Sussex, have already taken a ke interest in footpaths and done much of the surveyi and signposting required. Moreover, their work h already demonstrated how far success in this fie depends on co-operation with the urban distric parish councils, private landowners and volunta organisations such as the Ramblers' Association a the Commons, Open Spaces and Footpaths P servation Society.

The progress which some counties are already a to report in this field is one reason for hope, especial as it has indicated practical examples of co-operati between public authorities and voluntary organis tions, and some of the financial difficulties in rega to maintenance which hitherto have been responsi for reluctance to implement long-distance footpat such as the Pilgrims' Way, the coastal paths or t proposed Thames riverside walk from Teddington Cricklade. The National Parks Commission's selecti in this field must clearly be accompanied by reco mendations in regard to the cost of maintenance the Pennine Way and similar proposals are materialize. The financial clauses of the Bill provi for national contributions for that purpose, as w as to the Nature Conservancy.

So far as Nature conservation is concerned, the Bill supplements the powers conferred by royal charter on the Nature Conservancy and gives local authorities the necessary powers to set up local Nature reserves. Powers to acquire land compulsorily are conferred on the Nature Conservancy where it is expedient in the national interest that the land should be managed as a Nature reserve, or where there has been a breach of any agreement prejudicial to its management. Nevertheless, it is clearly intended that here also the normal method of acquisition or management shall be by voluntary agreement; and the full purpose of Nature conservancy as defined in the Bill—the provision of special opportunities for the study of, and research into, matters relating to the fauna and flora of Great Britain and the physical conditions in which they live, and for the study of geological and physiographical features of special interest, as well as the preservation of flora, fauna or such geological and physiographical features—will only be achieved with the full understanding and co-operation of all those concerned, whether private landowners or occupiers, local authorities, or Government departments.

These parts of the Bill are all linked up naturally with the wider and more controversial question of public access to the open countryside. Given that the Government is in earnest in its determination to stop the piecemeal encroachment of Government departments and make the establishment of national parks really effective, whether the purpose of national parks is achieved depends on public understanding and co-operation. There must be no confusion in the public mind between the different purposes of national parks and Nature reserves; the reasons for the different conditions of access must be clearly understood. Moreover, as was repeatedly emphasized in the debate, national parks in Britain, unlike those in other parts of the world, cannot be divorced from ordinary rural life. In them farming, rural industry and afforestation must function as nearly to normal as possible, and accordingly rights-of-way and public access to open country involve responsibilities and duties. The building up of a higher code of conduct on the part of those who enjoy the new opportunities, and the observance of that code less through penal enactment than under the compulsion of a public opinion that fully understands the reasons for the code, is a far surer way of securing the essential *rapprochement* between townsman and countryman.

This lies at the root of the whole matter; it is a disturbing feature in the life of Britain to-day that estrangement between townsman and countryman so readily arises. Numerous factors contribute to that discord; a significant recent example was the failure of farmers in Derbyshire to join with the Council for the Preservation of Rural England and the Ramblers' Association in opposing the extension of the Hope Valley cement works, although the taking of good farmland for clay-pits was the most vulnerable part of the scheme. The reception of Mr. Silkin's Bill in the House of Commons, however, testified to the existence of a large amount of goodwill and understanding on all sides. Strongly as the claims of agriculture were pressed, they were not advanced to the exclusion of other interests, and the whole spirit of the debate encouraged the hope that a satisfactory compromise between all interests will be found provided the Government deals resolutely with the tendency of Government departments to advance piecemeal proposals and attempt settlements which ignore other interests.

If the goodwill shown in the debate continues during the committee stage, the Act going to the Statute Book may satisfy most of the aspirations so widely entertained since Lord Addison's Committee first explored the question of national parks in 1930. Whatever the form of the Act, much will inevitably depend on Government action, public understanding and the establishment of a fresh harmony between townsman and countryman. Nothing could contribute more to the creation of the right atmosphere than a clear lead from the Government on the vexed question of land for the Services. Given this, and the imaginative and energetic exercise by the National Parks Commission of its functions of publicity and the provision of information services, there may be created a public understanding which will prevent the abuse of rights-of-way and access; further, by easing, if not removing, the clash of loyalties which the entrusting of the administration of the parks to local authorities at present involves, the Act will give Britain a system of parks and reserves which are, in fact and in spirit as well as in conception, truly national.

ORIGIN OF THE UNIVERSE

L'Hypothèse de l'atome primitif
Essai de cosmogonie. Par Prof. Georges Lemaître. (Les problèmes de la philosophie des sciences.) Pp. 203. (Neuchâtel: Éditions du Griffon; London: H. K. Lewis and Co., Ltd., 1946.) 8 francs; 10*s*.

PROF. GEORGES LEMAITRE is the eminent relativistic cosmologist (at one time a pupil of Eddington) who in 1927 independently discovered a solution of Einstein's gravitational equations which made the curvature of space depend on the time and so gave an explanation of the expansion of the universe of nebulæ. Actually he was anticipated by A. Friedmann, who had in 1922 and 1924 discovered forms of the fundamental metric of the homogeneous universe which involved the time; but Lemaître himself has always given the credit for the discovery to Friedmann, even to the extent of barely doing justice to himself. Lemaître's paper, which was published in Belgium, was overlooked by Eddington at the time; but it was due to Eddington that the Royal Astronomical Society published a translation of Lemaître's paper in 1931. In the present volume, Lemaître reproduces *seriatim* five addresses delivered by him on various occasions between 1929 and 1945, the title of the last of them giving its name to the present volume. There is also an inspiring preface by Ferdinand Gonseth, the distinguished professor of philosophy at Zurich. Though there are a few mathematical formulæ in the text, the style is that of semi-popular exposition, and detailed mathematical explanations are confined to an appendix.

The point of view of the author is that of orthodox relativity, and as a persuasive outline of that point of view in relation to world structure the addresses could scarcely be bettered. His account of 'curved space', illustrated by means of a Euclidean map, almost over-reaches itself; for why (the reader is inevitably led to ask), if the map is so successful, does the author consider the curved space as reality and reject the Euclidean equivalent as a mere map? He claims to prove that the number of stars in the universe must be finite, but the proof is question-begging. He believes firmly in the existence of the so-called 'cosmological constant', and believes, too, that it must be positive. But he admits, what is sometimes forgotten, that Einstein's relativistic theory of gravitation teaches us nothing about the signs or magnitudes of the two 'constants' of gravitation, and it is therefore surprising that he should be satisfied that a theory which goes so little into the fundamental nature of gravitation should be capable of explaining the origin and evolution of the universe.

This complacency, and consequent failure to see the need for a deeper theory of gravitation, run right through the volume. For example, his mathematical appendix opens with the unsatisfying statement that *proper time* is "the time for which identical experiences successively repeated have the same duration", when, as every philosopher knows, there is no recipe for saying what is meant by 'successive identical experiences', since you cannot put the fleeting minute side by side with a previous minute. Kinematic relativity, on the other hand, gives a rigorous definition of congruent clocks at a distance in any kind of relative motion, and it is because it really begins with fundamentals that it is able to refine on orthodox relativity to the extent of showing that in different dynamical contexts different scales of time are taken to be uniform.

The hypothesis of the primitive atom, a super-radioactive nucleus, as the origin of the universe and the source of nebulæ, clusters of nebulæ and cosmic rays, may seem at first sight, to the hard-boiled physicist, a mere piece of scientific romancing, but it is most attractively expounded by Lemaître. He admits that he may be pushing his description of the detailed sequence of events too far: an initial period of expansion; then a slowing-down as the universe passes through a near-equilibrium state corresponding to an Einstein universe; lastly, a further period of expansion, with the nebular clusters at a mean density of 10^{-27} gm. cm.$^{-3}$ as the fragments of an Einstein configuration of equilibrium between Newtonian inverse-square attraction and cosmological repulsion varying as the distance, and with cosmic rays as the fossil relics of the initial super-radioactivity. But it is becoming increasingly certain that any theory of evolution must envisage conditions near the natural zero of time drastically different from those now ruling.

Kinematic relativity agrees with the essence of Lemaître's hypothesis in tracing the state of the universe backwards to a point-singularity, before which there was neither space nor time nor becoming; and J. B. S. Haldane's related speculations at least show how some of the most vigorous minds of to-day are reacting in the same sense. The one thing that kinematic relativity insists on with regard to this singularity is that no propositions can be asserted about the state of affairs at that epoch; it is transcendent, as becomes the event of the creation of the universe. Lemaître's identification of this singularity with an actual super-radioactive atom seems to m too definite a thesis to maintain; indeed, to definite to have a chance of being true. Bu physicists and astronomers who are sceptical abou the value of theories of world evolution will at leas find food for thought and further reflexion i Lemaître's volume.

E. A. Milne

SCIENCE AND HUMANISM

Gods and Men

A Testimony of Science and Religion. By Sir Richard Gregory. Pp. viii + 214 + 8 plates. (London Stuart and Richards, 1949.) 12*s*. 6*d*. net.

Sir Richard Gregory and I have grown old together; his memory and mine go back to the days when religion and science were in open conflict and when Huxley was assuring his hearers that the more the methods of science took hold of mankind the less would be its belief in supernatural powers and influences. Sir Richard was a pupil of Huxley; no one is better qualified than he to bear testimony as to how the conflict has gone in the last sixty years For forty-five of these years he was editor of *Nature* —a position which entails an intimate knowledge of all branches of science and of the bearing of scientific knowledge on every form of human activity In "Gods and Men" he states, objectively and dispassionately, the relationship which does exist, as well as the relationship which ought to exist, between science and religion. He does not share my fear that the present truce is an uneasy one; the opposite—he is of opinion that the conflict is a thing of the past and that the future must see an active collaboration of science and religion if mankind is to prosper.

The following paragraph illustrates the manner in which Sir Richard states his case for the reconciliation of science and religion:

"In recent years it has become increasingly evident that this [the doctrine of immortality] and other traditional beliefs cannot have a place in progressive thought apart from scientific knowledge and historical evidence. Responsible leaders in the Church of England to-day represent a new and enlightened attitude towards the so-called 'heresies' of scientific thinkers, which convulsed English society in the nineteenth century from the days of Dean Buckland down to the pitched battles which took place on the scientific positions of Charles Darwin, T. H. Huxley John Tyndall and their successors" (p. 142).

I do not think that this instance can be accepted as evidence that science is causing religion to lose its hold on the great public. Indeed, Sir Richard recognizes this and admits that *most* church-goers regard "the acceptance of such views as a capitulation to the forces of modernism and scientific materialism" As evidence of the hold that religion has on the public of England I would cite the fact that the most worldly minded of newspapers adorn their opening page with a biblical text and that at all times the B.B.C. is offering a 'word in season'! Science in nowise hinders the drift of our most eminent literary men from seeking succour in the Roman Catholic Church.

Sir Richard is a devout humanist; for him humanism is a religion. Humanism he defines as "the integration of all human influences which promote the development of the human race, whether in ncludes the teaching of a particular religion or not. Whatever principles or practices raise man out of his nimal ancestry and add to his status among living reatures can rightly be termed humanistic." Humanists believe that human affairs go forward without interference from supernatural powers. However passionately an ideal for the betterment of nankind is held, unless the overlordship of a Divine ower is recognized, that ideal will not be accepted by he orthodox as worthy of the name of religion. Critics might rightly urge that it is humanism, not eligion as usually understood, which Sir Richard lesires to reconcile with science. Humanism and cience need no reconciliation.

Throughout the latter half of "Gods and Men" ir Richard directs his argument to support a high deal which he and his life-long friend, the late Mr. H. G. Wells, held in common—the ideal of all nankind being welded into a human brotherhood nd becoming members of a single world State. The essence of all great religious systems," he claims (p. 130), "is belief in the attainment of high leals by devotion of service to them." If we accept his claim, as men of science are likely to do, then Gods and Men" may be described as a religious ook and its author as an intensely religious man. One bar to the realization of this ideal is the irreconcilability of the doctrinal elements in world eligions. But if the doctrinal element is left out of consideration, there remains in all of them a common element—the ethical or moral element. It is out of this common or ethical element that Sir Richard sees the possibility of constructing a "world religion". "In this composite but practical creed," he maintains (p. 131), "it is permissible to consider the movements oward world fellowship as representing a further and higher stage in the development of religious belief, in which the theological differences which ntagonize will be forgotten in the pursuit of a common and universal moral purpose."

Huxley believed that as the kingdom of science extended its rule the reign of the supernatural would ose its hold on the minds of mankind. Gregory and have seen science become an ever more powerful factor in the life of man; but religion has not lost s hold on the human heart. That is because religion vas born in the human heart, not in the human head. It answers certain basal needs of the 'heart', hat is, of human nature. "The social and cultural onditions change," it is noted (p. 157), "but human ature remains in most respects unaltered". That, think, is why religion holds its own in spite of the great advance of science. Perhaps it is just the unmalleability of those mental elements which go to the make-up of human nature that now stands as the hief obstacle to the realization of Sir Richard regory's ideal—a universal brotherhood.

In writing this book the author has submitted himself to the rigorous discipline of the scientific method; even when dealing with those matters of doctrine, to the handling of which religious minds are most sensitive, his methods of statement remain purely objective. He is critical but never aggressive. Yet his application of the method of science to religious roblems seems to have given offence in some quarters. In a literary journal where orthodoxy is upheld, a ritic has bluntly stated that "Gods and Men" is a ook which should never have been published. The ish to suppress such a book is evidence that the onflict between science and religion is not yet over.

ARTHUR KEITH

ORIGIN AND GROWTH OF THE ROYAL SOCIETY

Scientists and Amateurs

A History of the Royal Society. By Dorothy Stimson. Pp. xiii + 270 + 20 plates. (London: Sigma Books, Ltd., 1949.) 15*s.* net.

IN the present century we have grown so accustomed to the supremacy of the Royal Society in all matters scientific that it is difficult to realize it has not always possessed its high reputation. Such is its authority and its high seriousness to-day that it is hard to believe there have been times when it has been scoffed at and derided for the triviality of its pursuits. Yet this is the case. The Society derives its reputation from the scientific eminence of its members; yet there have been long periods in its history when a majority of those elected to its fellowship have not been men of science at all, when election has been a mark of social rather than of scientific distinction.

Other histories of the Royal Society have been published, written, as histories of institutions often are, by those intimately connected with its administration and drawing on personal knowledge of the various aspects of its affairs. The work under notice is of a different character. It is the outcome of a study by Miss Stimson of seventeenth-century science in England, and as an essential part of that theme, an inquiry into the origins and growth of the Royal Society. The result is a book for the general reader, primarily the American reader, written in a detached and objective manner, and setting the history of the Society against the intellectual, social and historic background of the seventeenth and later centuries. It is an interesting, indeed an absorbing story, and the treatment is original and refreshing.

The title is, I think, a little misleading. It draws a distinction between the professional men of science and those amateurs, the *virtuosi*, who played such a large part in the foundation and the early activities of the Society; but there is a sense in which all true scientific men have remained amateurs, and there are among us, even to-day, some few individuals whose devotion to science is a thing apart from their bread-and-butter interests. In this regimented and socialized age, when we are all classified and labelled, it is well to remember that there are still some who have made great contributions to knowledge, and yet cannot readily answer the question, "What is your profession or occupation?" They have preserved that independence and integrity of mind from which must always spring the advances of the human intellect.

Miss Stimson passes in brief survey the writings of Francis Bacon, the ideas of such men as Comenius and Hartlib, of John Evelyn and Robert Boyle, of Sir Thomas Gresham and his College in the City of London, of the whole movement towards the new learning based on experiment and observation which culminated in the foundation of the Royal Society by Charles II. The meetings of the 'Invisible College' in London and Oxford preceded this royal recognition and encouragement. One of Charles's principal scientific interests was the progress of astronomy as an aid to navigation, and there grew out of this, on the establishment of the Royal Observatory and the setting up of John Flamsteed as the first Astronomer Royal, the association of the Royal Society and the Royal Observatory which has lasted ever since.

Charles's great Navy secretary, Samuel Pepys, was one of the early presidents of the Society. The Society's connexion with the Royal Observatory is closely paralleled in more recent years by its responsibilities for another great national institution, the National Physical Laboratory. From the earliest years the Society has been consulted by the Government in scientific matters, and the advice it has thus been able to give constitutes one of its most valuable public services.

It is well known that King Charles poked fun at the Society "for spending time only in weighing of ayre". There were other and more serious criticisms, in the early years, of the unsubstantial quality of many of the papers published, to which were added financial troubles, and problems of accommodation. Despite the reputation of Newton and the prestige conferred upon it by his presidency, the Society had many difficulties and some opposition with which to contend before it became firmly established. Later, at the end of the eighteenth century, during the long and autocratic presidency of Sir Joseph Banks, there were acute dissensions among the members and strong criticism of the methods of election to fellowship.

Gradually, however, reforms were introduced; scientific attainment was established as the essential qualification for admission of the great majority of the members, and the leading men of science came into control of the administration. By the middle of the nineteenth century, despite the competing activities of the many specialized societies which were being formed, the Royal Society had achieved the position of unchallenged leadership and authority which it holds to-day.

This book is the more valuable because it is obviously the outcome of extensive reading and careful investigation. Miss Stimson has special reasons for her interest in the American contacts of the Society, and has given many interesting particulars of the membership of Cotton Mather, Benjamin Franklin, and other prominent Americans.

THOMAS MARTIN

APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 9: Oils, Fatty—Pituitary Body. With an Index by Dr. J. N. Goldsmith. Pp. viii+671. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 80*s*. net.

THE national importance of the chemical industry, and of those allied industries which depend upon chemical science, is reflected to-day in the pronouncements of Ministers and the figures of trade. Chemical technology becomes increasingly scientific, and chemistry constantly makes available new knowledge of materials and reactions. It is essential that this new knowledge should be assembled in a convenient form. Moreover, in these days when we are in danger of being overwhelmed by a mere mass of information, it is most valuable to have it filtered and screened by experts.

The appearance of a further volume of the new edition of "Thorpe" is therefore to be greeted with pleasure and gratitude, both because of the wide range and the authoritative treatment of the subject-matter. The present volume, No. 9 in the series, contains articles from some seventy authors, and the general level of the contributions may be indicated b some samples. Dr. E. J. Bowen writes on "Photochemistry", Dr. U. R. Evans on "Passivity", Prof T. P. Hilditch on "Oils and Fats", Prof. E. L. Hirs and Dr. J. R. N. Jones on "Pectin", and Mr. B. Tople and Dr. B. Raistrick on "Phosphorus". The inclusio of contributions from distinguished overseas author such as Prof. J. H. Quastel (oxidizing enzymes), D Gustav Egloff (petroleum), and Prof. R. J. William (pantothenic acid) is a pleasing feature. The centra position of chemistry in science is well exemplifie by a comparison of the largely mathematical articl of Dr. E. A. Moelwyn-Hughes on "Partition Function" with monographs from the biological end of th subject, such as that by Dr. E. Lester Smith and hi collaborators on "Penicillin".

Sir Ian Heilbron and his colleagues on the editoria board are to be congratulated on the general high leve of achievement. The world of chemistry is in debt t them and to the authors alike.

R. P. LINSTEAD

A STUDY OF IBO LIFE

Ibo Village Affairs

Chiefly with Reference to the Village of Umuek Agbaja. By M. M. Green. Pp. xi + 262. (London Sidgwick and Jackson, Ltd., 1947.) 10*s*. 6*d*. net.

THIS book is a valuable contribution to ou understanding of the Ibo, not for the facts i contains but for the very clear exposition Miss M. M Green gives in Part 1 (Village Organisation) of th general, almost conscious, tendency of the Ibo peopl to disperse authority over as many groups as possibl —whether based on age, sex, occupation or anythin else—rather than to concentrate it in the hands o any central organisation. There are, as she point out, no recognized bodies, either judicial or legislativ that function to the exclusion of other groups, fc any group "can take the initiative and win the day i they can secure enough popular support". Many the difficulties in establishing indirect rule in this pa of Nigeria might have been lessened, if not avoide if this had been fully appreciated earlier.

Parts 2 (Exogamy) and 3 (Women's Organisation are of less general application. The argument th the system of exogamy (whereby all the daughte are married into, and all the wives drawn from, oth villages) forms one of the strongest links by whic villages, in the absence of any political ties, a joined together is probably true of Umueke Agbaj and similar communities where the exogamous un is the village. Exogamy undoubtedly is a cohesi element; but its effect will obviously be of less politica and even social, importance in other parts of I country where the exogamous unit is the extend family and where large numbers of women spen their life in the village or village group in which the are born.

Miss Green adds an interesting appendix in whic she attempts to interpret the Ibo temperament the light of the conclusions reached by Dr. Mur Mackenzie, particularly in his book, "The Hum Mind". Her views are tentative and are, as it wer merely set out for our consideration. But they a certainly thought-provoking, and investigations alo the lines she suggests may well do much to raise t 'iron curtain' which all who have worked among t Ibo feel to exist between the minds of these peop and their own.

J. O. FIELD

NEW EVIDENCE ON THE STRUCTURE OF SOME PROTEINS FROM MEASUREMENTS WITH POLARIZED INFRA-RED RADIATION

By E. J. AMBROSE, Dr. A. ELLIOTT and Dr. R. B. TEMPLE
Research Laboratory, Courtaulds, Ltd., Maidenhead

CURRENT views on the structure of keratin, myosin and related proteins are based on chemical analyses and on X-ray diffraction data. The X-ray evidence (Astbury and Street[1]) shows that these proteins may exist in either of two forms, α and β, each of which shows a characteristic X-ray diffraction photograph. The most intense meridian reflexion corresponds to a chain spacing in the α-form of about 5·1 A., while in the β-form the chain spacing is about 3·3 A. Since it is possible, after suitable softening treatment, to change a natural protein in the α-form to the β-form by stretching or squeezing, it is generally assumed that the polypeptide chains in the α-form are folded in some way, whereas the β-form corresponds to the extended chain. Astbury[2] has proposed a particular form of folding for α-keratin; Huggins[3], Wrinch[4], and Wrinch and Jordan Lloyd[5] have suggested a number of other possibilities. In an interesting recent paper by Astbury, Dalgleish, Darmon and Sutherland[6] the properties of some synthetic polypeptides and natural proteins have been discussed, both from the point of view of X-ray diffraction and infra-red absorption.

We have been engaged in applying measurements made with polarized infra-red radiation to problems of high-polymer structure and have been working on synthetic polypeptides prepared in this laboratory (Hanby, Waley and Watson[7]). An interesting result observed in oriented polyglutamic ester and in α-keratin has already been briefly reported (Ambrose and Hanby[8]). In oriented (rolled) polyglutamic ester and in keratin obtained from porcupine quill, the preferred direction of the N—H bonds is shown by polarized infra-red measurements to be parallel to the chain orientation. This strongly supports the view that the backbone or chain is folded to form a seven-membered ring as indicated by them[8] and shown in Fig. 1. A fold of this kind differing from the above only in the arrangement of the side-groups has been suggested by Huggins[3]. The arrangement of the side-groups shown in Fig. 1 transforms more easily into the β-form and will fold about an axis parallel to the plane of the rings.

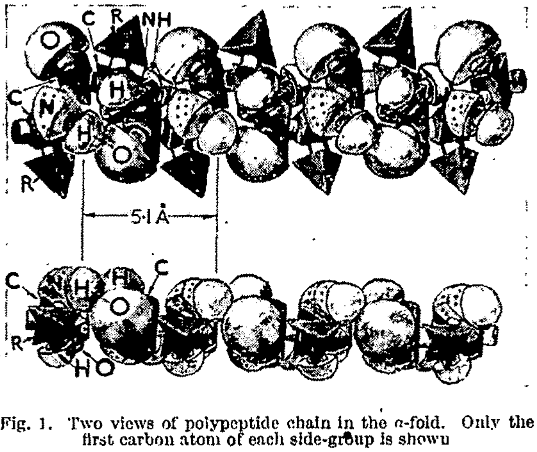

Fig. 1. Two views of polypeptide chain in the α-fold. Only the first carbon atom of each side-group is shown

In view of the importance of the interpretation of the α-structure, we have examined several proteins of the keratin–myosin group. The results, described below, are all in harmony with those obtained in the first instance with polyglutamic ester and α-keratin.

Experimental Evidence

The spectra were recorded in the 3-μ region with a lithium fluoride spectrometer equipped with a selenium transmission polarizer (Elliott, Ambrose and Temple[9]), and tracings are shown in Fig. 2. The keratin specimens were cut sections of porcupine quill (α-keratin) and of swan quill (β-keratin). For orienting specimens of myosin and tropomyosin, the proteins were cast on thin films of rubber, which were afterwards stretched. This technique, which we believe to be new, solved a difficult problem. It was found that cast films of tropomyosin often showed some orientation after drying; this is, no doubt, a consequence of the fact that the material forms fibrillar aggregates in solution (Astbury, Reed and Spark[10]). The myosin was prepared by Edsall's method[18], and tropomyosin was made according to the description given by Bailey[11].

The main features of all the spectra are the bands due to stretching frequencies of the C—H bonds at about 2,900 cm.$^{-1}$, and two bands which almost certainly arise from N—H stretching modes, a strong band at about 3,310 cm.$^{-1}$ and a much weaker one at about 3,060 cm.$^{-1}$. Both N—H bands show parallel dichroism in myosin, tropomyosin and α-keratin, but are markedly perpendicular in feather keratin, which occurs naturally in the β-form (Astbury and Marwick[12]) and is highly crystalline.

Interpretation of Spectra

These facts can be interpreted, as already stated, if it is assumed that the polypeptide chains are folded in the α-form and extended in the β-form. It may be argued that the differing dichroism may arise from the nitrogen atoms on the side-chains; but it is generally considered that the nitrogen is present in the side-groups as $\overset{+}{N}H_3$, and from observations which we have made on glycine ($\overset{+}{N}H_3\,CH_2\,\overset{-}{C}O_2$), the zwitterion form appears to give rise to a very broad absorption band extending from about 2,900 to 3,400 cm.$^{-1}$, with a maximum at 3,160 cm.$^{-1}$. It seems, therefore, that though the side-chain $\overset{+}{N}H_3$ will contribute to the general level of absorption, the bands at 3,060 cm.$^{-1}$ and 3,310 cm.$^{-1}$ can be attributed to the polypeptide N—H linkages. It appears reasonable to assume that in α-keratin and in the α-forms

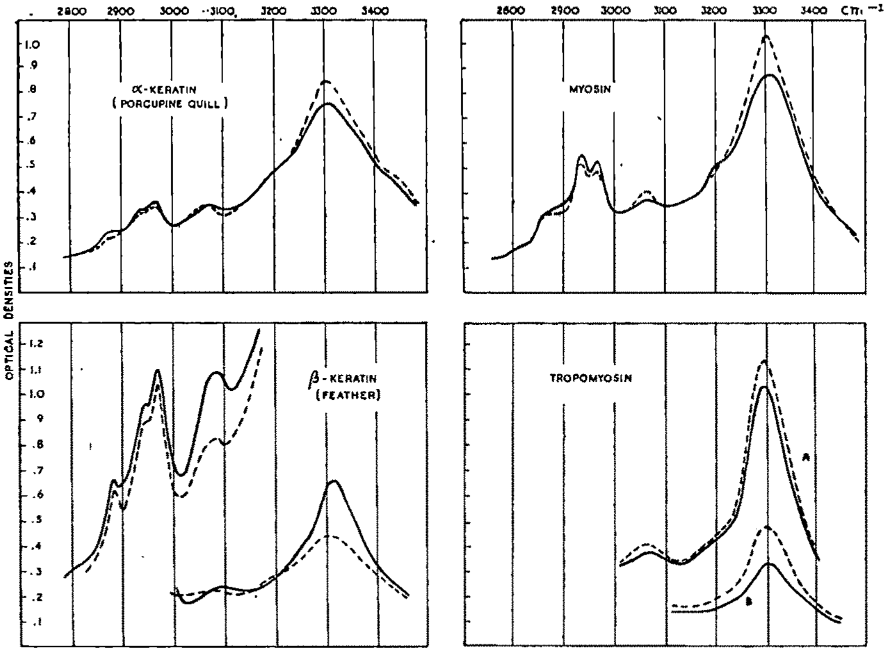

Fig. 2. Infra-red spectra of proteins, using polarized radiation. Full and broken lines show spectra with the *E*-vector respectively perpendicular and parallel to the chain axis. In the tropomyosin spectrum, *A* was obtained with a specimen self-oriented on drying; *B* was a thinner specimen stretched on rubber film. The high-frequency band in β-keratin was obtained with a thinner specimen than that used for the lower-frequency region

of myosin and tropomyosin the same backbone structure is found as in polyglutamic ester, since the same type of dichroism is found in the N—H bands in all these molecules. Without the work on a polypeptide in which there is no nitrogen on the side-groups, one would, however, hesitate to propose a structure for the protein backbone from the infra-red observations.

The weak band at 3,060 cm.$^{-1}$ is ascribed by Astbury, Dalgleish, Darmon and Sutherland[6] to a type of hydrogen-bonded N—H. It is sensitive to changes in structure; for example, Astbury *et al.* found that it weakened in tropomyosin on changing from the α- to the β-form, and we have found that it is weakened in nylons by melting, and by solution in *iso*butyl alcohol. In the proteins we have examined it shows the same type of dichroism as the strong N—H band, generally giving a somewhat higher dichroic ratio. Although a weak band, it may be structurally important, since the low frequency suggests strong hydrogen bonding.

Attention may be directed to the great similarity in the C—H stretching frequencies in α- and β-keratin (apart from the much higher density in the β-specimen caused by the use of a thicker specimen). The similarity of the three peaks includes frequency, relative intensity and dichroism. This may be taken to mean that the arrangement of the side-groups relative to the fibre axis is not greatly different in the two forms. The contrast with the N—H frequencies is striking.

Discussion of Proposed Model

The arrangement shown in Fig. 1 appears to be the one which will give the highest parallel dichroism for the N—H absorption bands. The structure proposed by Astbury[2] gives little preferred direction for the N—H bonds; other arrangements proposed by Huggins[3] as alternative to his '*a*'-fold would give low dichroism also. The spiral shown by Huggins in Fig. 13 of his paper also appears to give about the required amount of parallel dichroism. Although possibly fitting the X-ray observations rather better than the '*a*'-fold, this spiral has the serious objection that it is practically rigid. Moreover, the α–β transition would require that many of the side-chains would have to rotate through an angle of 180°, which in a material such as keratin containing numerous intermolecular cystine and salt linkages seems highly improbable. Calculation based on densities, unit-cell dimensions and residue weights do not allow a choice to be made between four or three residues per unit cell, and hence do not discriminate between the '*a*'-fold and the spiral. Although the dichroic ratios shown in Fig. 2 are not high, the result for tropomyosin shows a dichroic ratio almost as high as we have obtained for the same N—H band in a rolled nylon specimen, though in nylon, of course, the band is of perpendicular character. We have pointed out elsewhere[16] that in nylon (as in other polymers) the dichroism of many bands is not as high as the orientation of the crystalline regions would lead one to expect, taking into account the known direction of the covalent linkage involved, which, in the case of the nylon N—H linkage, is perpendicular to the chain axis. We feel, therefore, that the evidence favours the structure which would show the greatest parallel dichroism in the proteins examined.

X-Ray Data

The true repeating unit along the fibre axis for the model shown in Fig. 1 is 5·1 A. Huggins[3] considers that it is necessary to assume that alternate side-chains are more potent scatterers of X-rays in order to account for the intensity of the 5·1 A. reflexion. Possibly a slight bending or staggering of side-chains of neighbouring molecules resulting from *inter*-chain salt linkages will account for the intensity.

MacArthur[17] has resolved two strong equatorial reflexions of 9·2 and 10·5 A. spacing in α-keratin. One of these, possibly the 9·2 A. spacing, may correspond to the side-chain spacing as in β-keratin, while the other of 10·5 A. may correspond to the spacing between pairs of α-ribbon molecules. The α-ribbons will presumably run alternately parallel and anti-parallel (with respect to the —NH—CO—CH*R*— units along the chain), as they are thought to do in β-keratin (Huggins[3]). These pairs of chains may be packed in a hexagonal array; Perutz has discovered a hexagonal packing of α-folded chains in hæmoglobin crystals.

Fellows would have a special responsibility, if only by reason of their freedom from undergraduate teaching, to play a major part in advanced teaching and graduate studies, and the undertaking of major pieces of research.

A second main difference is that Nuffield is a graduate college. The College may have not more han forty Students at any one time, and these must be reading for the degrees of D.Phil., B.Litt. or B.Sc., or be otherwise engaged in or contemplating approved research. A purely graduate college is, of course, something of an experiment in Great Britain. It is particularly striking that the development should have taken place in a university whose main pride, and rightly so, is in its honours schools. But this year there are about a thousand students reading for advanced degrees in Oxford, the great majority being in medicine or science, so that while increasing the numbers passing through the various honours schools and maintaining the same high standard, the University is also making a major contribution to training of research workers. In medicine and the physical and natural sciences, the graduate finds a base and a place for meeting other researchers in his broad field in the hospital and the laboratories. In social studies he is liable to find himself rather isolated, particularly if he did not take his first degree in Oxford. He has his supervisor, but he loes not fit very easily into the college of which he is a member, for the great majority of the other students will be reading for their first degree. By being also associated with Nuffield College, however, he is brought into close contact with other advanced students in social studies. Already, by providing laily lunches at which Fellows and students eat ogether, by holding special seminars and in various other ways, the College is going some way to provide a corporate life for graduate students in social studies. When at some future date the buildings are complete, there will also be a residential centre.

The main problem at the moment is to find first-class graduates capable of undertaking advanced work in social studies and to keep hold of them. The College offers studentships which may be up to £300, according to needs. At present, however, there is a very heavy demand from Government departments, industry, the universities, and from many other quarters for those who have just graduated with good honours degrees in economics, etc. In many cases, when we have been fortunate enough to get hold of first-class graduates, they have gone off within one or two terms to some attractive university appointment. This is only to be expected at the moment, and we have been glad to have had such capable young men associated with us, even for a short time. It is probably true to say that many of those and of our existing Students would have been lost for university work if Nuffield College had not been able to give them financial aid, for though there are many scholarships and grants available to undergraduates, there is little money for the student who wishes to continue beyond his first degree. It is to be expected that as the present pressure of demand declines, more students will be available for postgraduate work in social studies.

One final point: the founder in his wisdom saw that research in social studies might well be arid unless the College was brought into direct and close contact with practical affairs. There is thus the phrase in the statute governing the College: "to encourage research . . . especially by making easier the co-operation of academic and non-academic persons". This co-operation is helped by the College having visiting Fellows, chosen for their ability to further research in the College by virtue of "their practical experience in the professions or in industry or commerce". They are full members of the College and its governing body. At the moment the College has six visiting Fellows: Lord Beveridge, Mr. Harold Clay, Sir Geoffrey Heyworth, Mr. Herbert Morrison, Sir Raymond Streat and Sir John Henry Woods. It is of great value to have such distinguished men of affairs as these associated with the College and willing to give help and advice in the studies being undertaken there. Another method of co-operation, which owes so much to Prof. G. D. H. Cole and Lord Lindsay, is the private conferences held from time to time. The College invites some forty or fifty people drawn from industry and commerce, government and public affairs and the universities to discuss one or more questions of current importance. During the summer two such week-end conferences are to be held to consider certain problems raised by large-scale organisations and the nationalized industries.

THE GENETICAL SOCIETY

THE Genetical Society holds its hundredth meeting in Cambridge on June 30 and July 1. A number of foreign guests are being invited to the meeting, at which it is planned to present a picture of the growth of genetics and its scope in Britain to-day.

The Society was founded in 1919 by William Bateson, its first president being the Earl of Balfour, whose name is also associated with genetics in the title of the Arthur Balfour chair at Cambridge. Lord Balfour held the office of president until his death in 1930, when he was succeeded by Prof. R. C. Punnett. Since that time it has been customary for the presidency to be held by a professional geneticist for a limited number of years.

The aim of the Society is "to promote the Advancement of Genetics and intercourse among persons interested in that science", and it accepts to membership those who are or have been engaged in genetical research or teaching in the applied genetical fields of plant and animal breeding, or are in other ways attached to the study of the subject. Ordinary membership is thus in no way narrowly restrictive, and, indeed, it now stands at nearly two hundred. In addition, there are twenty overseas members who between them cover most parts of the world. The Society also elects to honorary membership eminent geneticists both from Great Britain and from overseas.

The hundredth meeting is being held just thirty years after the Society was founded—an average of some three meetings a year. These meetings normally take one or other of three forms. For some of them members submit papers dealing with their own researches. Others are organised as symposia on subjects of general interest, contributions being arranged by invitation. These symposia have often been organised and held in collaboration with some other learned society. Thus, genes and chromosome behaviour have been discussed jointly with the Society for Experimental Biology, disease resistance as it relates to plant and animal breeding with the Association of Applied Biologists, the genetics of fungi with the Mycological Society, and micro-organisms with the

Biochemical Society. The third form, which is generally adopted for the summer meetings, is that of visits to genetical laboratories or other places of interest to geneticists. On these occasions primary emphasis is placed on seeing the work in progress and the methods which are used there.

The Genetical Society played a large part in the Seventh International Genetical Congress held in Edinburgh in 1939. It has also always taken the opportunity of inviting geneticists from overseas, who might be visiting Britain, to attend its meetings and to read papers. In this way many eminent geneticists have been the guests of the Society, including the two Nobel Laureates in genetics, T. H. Morgan and H. J. Muller. Since the War a still more positive international policy has been adopted. Scarcely, in fact, was the War over before, in November 1945, the Society held a conference to which were invited geneticists from most of the western European countries and from the United States. Accounts were presented of the progress of genetical work in Britain during the war years, and the foreign visitors described activities in their own countries. Coming when it did, this meeting was appreciated by all as being not only a very happy occasion, but also one of the greatest value in renewing personal exchange of views, and going far to remedy the difficulties caused by lack of free communication during the war years. A further and similarly successful international conference was arranged in 1948 on genetics in relation to cancer problems, this time in co-operation with the British Empire Cancer Campaign.

The history of the Genetical Society is one of steadily increasing membership and steadily widening interest. The growing importance of genetics for other branches of science has been reflected in the Society's co-operation with other bodies in joint discussions. The growing strength of genetics has equally been reflected in the international conferences that have been held. Genetics has, indeed, changed and grown profoundly in the last thirty years, and the process is accelerating rather than declining. The Genetical Society has a great part to play in these changes if it is to serve the science in the future as it has done in the past. It must not merely continue, but strengthen, its efforts to combine the well-established function of promoting intercourse among its members, and the special branches of the science that they practise, with the newer and broader purpose of presenting genetics as one of the focal points not only of biology as a whole, but also of agriculture, medicine and the non-biological sciences; and it must do so on no narrow national basis. The developments, especially of the last few years, show that the Society is aware of these growing responsibilities. Looking back over its first hundred meetings, it may justly face the future with confidence in its ability to meet the needs of the time.

OBITUARIES

Sir Wyndham Dunstan, K.C.M.G., F.R.S.

Sir Wyndham Rowland Dunstan, director of the Imperial Institute during 1903–24, who died on April 20, aged eighty-seven, rendered great service to the British overseas countries. Educated at Bedford School and abroad, Dunstan commenced a notable scientific career as an assistant in chemistry to Prof. Th. Redwood at the School of Pharmacy o the Pharmaceutical Society and succeeded him in 1885 as professor of chemistry, a position held for ten years, during which, in 1887, he became director of the Society's new research laboratories. Simultaneously, he held the post of demonstrator in the University laboratories, Oxford (1884), and in 1885 was appointed University lecturer in chemistry in its relation to medicine. The medical bias of his work was confirmed by his appointment to the professorship of chemistry at St. Thomas's Hospital (1892–1900). Dunstan's organising ability led him to serve as secretary of the Chemical Society (1893–1903), and he was a vice-president of the Society during 1904–06. He was a member of Council of the Royal Society and at the York meeting of the British Association in 1906 was president of the chemistry and agriculture section.

During the earlier years, Dunstan published many papers on the chemistry of drugs; but his major original work was done largely in collaboration with other workers, notably Prof. J. T. Cash, T. A. Henry, E. Goulding, F. H. Carr, H. Brown and A. E. Andrews. Much of the work, for example, that on the pharmacology of aconitine and its derivatives (with Cash), the Indian aconites, podophyllum, and *Hyoscyamus* alkaloids, was still of pharmacological and medical interest; but the research with Goulding on oximes was purely chemical in interest, and that in association with Henry on cyanogenesis in plants was a new field of much scientific and practical importance.

Sir Wyndham's real life-work, however, in which his abilities as man of affairs had full play, was done at the Imperial Institute, which was founded to investigate and display the raw materials of British overseas countries with a view to their commercial utilization. He was appointed director of the Scientific and Technical Department in 1896, and succeeded Sir Frederick Abel in the full directorship of the Institute in 1903. Possessed of clear insight, decision and driving power, he recognized promising lines of work, and, with the help of a staff devoted to the mission of the Institute, greatly extended the laboratory and intelligence services, established technical advisory committees and carried through investigations which have proved of great and lasting value to the overseas countries in developing their natural resources. Particularly valuable work was done in connexion with the much-needed extension of cotton cultivation, and Dunstan's reports on "British Cotton Cultivation" (1904 and 1908) and on "Cotton Cultivation of the World" (1910) summarized the position at those times. He was president of the International Association of Tropical Agriculture in 1910 and of the International Congress of Tropical Agriculture in 1914. In 1916 the circumstances of the War suggested an inquiry into the possibilities of increased use in Britain of certain Indian raw materials, and, at the invitation of the Secretary of State, Dunstan organised, through the Imperial Institute Committee for India, an inquiry into the subject, which resulted in a series of valuable reports. On the mineral side, Sir Wyndham's official "Report on the Coal Supply of India" was published in 1898. At his instance, and under the auspices of the Imperial Institute, Colonial mineral surveys were established in Nigeria, Nyasaland and Ceylon, which had important practical results and laid the foundations of the present Colonial geological surveys. Meanwhile, the quarterly *Bulletin of the Imperial*

Institute had been first issued in 1903, and this publication rapidly increased in importance.

Dunstan early recognized the potential educational value of the public exhibition galleries of the Imperial Institute. He secured the appointment of a scientific staff which commenced the reorganisation of the galleries, and under his direction set in train their evolution, which has advanced step by step with the economic and social development of the overseas countries. He was honorary treasurer and secretary of the Sudeley Committee, and furthered the objects of that body by appointing a guide lecturer in the galleries and encouraging conducted visits of school parties.

By official requests Dunstan visited Cyprus, Asia Minor, Ceylon, India and Newfoundland, and prepared reports on their economic development.

Sir Wyndham, together with Dr. A. Senier, was a founder and a vice-president of the Aristotelian Society. He married as his second wife Violet M. C. Hanbury Tracy, and she survives him.

S. E. Chandler

Sir Robert Robertson, K.B.E., F.R.S.

Robert Robertson passed away on April 28 after a short illness which ended a very strenuous life. He was working at his researches in the Davy Faraday Laboratory almost up to the last, although he was in his eightieth year. I was first associated with him in 1900 when he was directing the laboratory of the Royal Gunpowder Factory at Waltham Abbey. In those days, almost half a century ago, ideas as to scientific control in manufacture were very modest, and the scale of remuneration was even more modest; and so this important Government factory had a staff of five or six chemists only, and their duties were many and diverse.

While at Waltham Abbey, Robertson carried out an important investigation which cleared up the then obscure question of the stabilization of guncotton, and made it possible to rationalize the method of boiling. Together with his colleague, the late William Rintoul, he worked out in his own time a process and plant for the recovery of the acetone used in the manufacture of cordite, and this was installed in the Royal Gunpowder Factory.

In 1907 he was transferred to the Research Department at Woolwich Arsenal, which had been started a few years before, largely at the instigation of Lord Haldane, as a counterpoise to the German *Zentralstelle*. There he directed the laboratories, and his work was again concerned principally with explosives. He continued accurate determinations of the calorimetry of propellants, work which proved of great value during the First World War, when it became necessary to modify the composition of cordite on account of the shortage of acetone. T.N.T. having been adopted for filling high-explosive shells, the manufacturers in Great Britain had difficulty in making enough of it, so Robertson and his staff worked out a process and erected a pilot plant, which was copied on a very large scale at the new factories at Oldbury and Queensferry.

Robertson was elected to the Royal Society in 1917 and was made a K.B.E. in 1918. In 1921 he became Government Chemist, and the range and scope of his activities were greatly extended, but he also found time and energy to carry out researches after hours. With his colleagues he investigated the infra-red spectra of ammonia and phosphine, and so was a pioneer in a branch of physical chemistry which has now become a most important means of investigating molecular structures. He also made discoveries about the structure of diamonds.

In 1931 he was one of the organisers of the chemical section of the Faraday Centenary Exhibition held at the Albert Hall, London. His acquaintance with research workers and laboratories throughout the kingdom enabled him to help bring together a most interesting lot of exhibits, and he inspired the whole of his staff with his own enthusiasm.

He retired under the age limit in 1936, but his activities did not cease, and he continued his researches, now in the Davy Faraday Laboratory; and in 1937 he was appointed director of the Salters' Institute of Industrial Chemistry. The Second World War, however, stopped these researches, as he rejoined the Research Department and took charge of the branch of it which was opened at Swansea. He also became chairman of several research committees, an activity for which he was specially fitted. After the War he went back to his laboratory bench in Albemarle Street and resumed other activities; but even his vitality was ultimately exhausted.

One of Robertson's greatest fields of work was the Royal Institution, of which he was secretary during 1926–29, and treasurer until 1946. During this time he helped to raise a very large sum for rebuilding practically the whole of the Institution and endowing its work.

Robert Robertson was born at Cupar in 1869. In 1903 he married Kathleen Stannus; he leaves a son and a daughter.

Arthur Marshall

Dr. W. J. Perry

W. J. Perry's interest in anthropology developed while he was reading mathematics at Cambridge and had the good fortune to come into close contact with W. H. R. Rivers, when the latter was concerned with external sources of ritual and other cultural features in Melanesia and was interested in Elliot Smith's studies of archaic ritual in Egypt. Perry took up the whole question of evidence for the survival of elements of ancient Egyptian cults, beliefs and institutions in other parts of the world. For a while this was a leisure occupation, but on his invitation to join Elliot Smith at Manchester as reader in comparative religion, he was able to devote himself entirely to these questions, learning Dutch in order to make a detailed study of the Indonesian material, which he published in his first major work, "The Megalithic Culture of Indonesia" (Manchester, 1918).

Perry then proceeded on a programme of much wider scale which sought to demonstrate the diffusion of archaic cults as part of an early cultural complex throughout southern Asia, the Pacific and much of North America. His hypothesis concerning a world-wide archaic culture of predominantly Egyptian origin was set out with a wealth of detail in "The Children of the Sun" (1923), published at the time of his appointment as reader in cultural anthropology in the University of London. Perry's later work in London was increasingly hampered by severe illness, which compelled him to retire in 1939; but he made a number of supplementary studies, notably of the diffusion of agriculture, related crafts and ritual in prehistoric Europe in "The Growth of Civilisation" (1924) and of cosmological ideas among Oceanian and other peoples in "The Primordial Ocean" (1935).

It is now generally held that Perry, like Elliot Smith with whom he worked so closely in this field, over-simplified the processes of cultural diffusion, and sometimes too readily assumed that similarities of a general or formal kind, such as the practice of similar crafts or beliefs in sky beings, were indubitable evidence of particular connexions and unitary origins. The insistence on an exclusively Egyptian source for archaic cultural features also unfortunately rendered many of his generalizations unacceptable to specialists on the early cultures of the ancient East, on which new excavations and comparative studies were accumulating a wealth of fresh material. Controversies as to Egyptian versus Sumerian or Babylonian origins often side-tracked the opportunity for collaboration between prehistorians and ethnologists in the comparative study of relations between prehistoric and living civilizations in southern Asia. But the late A. M. Hocart brought strong support for some of Perry's contentions in his comparative studies based on field research on coronation rites and other archaic ceremonials in India, Ceylon an Oceania.

Even though it be held that he claimed too much Perry's studies established the importance of earl centres of higher civilizations as factors in shapin the form and symbolism of human cult and belie over wide areas of so-called primitive culture. In th years that have followed, interest in cultural anthropology in Britain has moved strongly in othe directions; but Perry will be remembered for hi passionate convictions, his amazing industry, hi vigour as a controversialist and not least for hi warm humanity as a colleague. DARYLL FORDE

WE regret to announce the following deaths:

Dr. Norman R. Campbell, formerly of the Researc Laboratories of the General Electric Co., Ltd. Wembley, on May 18, aged sixty-nine.

Mrs. Nernst, widow of Prof. Walther Nernst For.Mem.R.S., who had been living with her daughte for the past three years in Wimbledon, Surrey, o May 4.

NEWS and VIEWS

Physical Society's Duddell Medal: Dr. E. H. Land

THE Duddell Medal for 1949 of the Physical Society was presented on June 2 to Dr. Edwin Herbert Land, inventor of the polarizing material 'Polaroid'. Though attempts had been made by previous workers to replace the costly and limited Nicol prism with dichroic substances in the form of thin laminæ, Land was the first to demonstrate the possibility of manufacturing such laminæ with sub-microscopic dichroic crystals of quinine iodosulphate correctly oriented to simulate a single crystal extended to a superficial area previously considered impossible. This method is now being superseded as the result of two stages of further development. In the first, a plastic medium is stretched to cause orientation of the micelles. It is then soaked in a solution of the iodonium compound, which is precipitated on the oriented micelles to produce a polarizing medium. In the final method, a stretched plastic medium is treated in a way which converts about 1 per cent of its bulk to a polyvinylene compound, a straight-chain polymer in which the double-bonded oxygen gives the necessary intense directional light absorption. It is claimed that this material is extremely heat-stable and very efficient. The light transmission of the single sheet is about 40 per cent, and is reduced to 0·02 per cent for two sheets in the crossed position. This is a very remarkable development of the original idea. First, Land has succeeded in eliminating the step of orienting sub-microscopic crystals of the iodonium compound; secondly, he has eliminated the compound altogether.

Land has also described an ingenious system of stereoscopic photography in which the two images are formed in two layers of polarizing crystals crossed with respect to each other and mounted on an aluminium background. Stereoscopic pictures on this principle were developed by the Polaroid Corporation under the name of 'vectographs' (*J. Opt. Soc. Amer.*, **30**, 230; 1940). A further novel development described by Land is a one-step photographic proces in which the positive print can be produced in abou one minute from the time the photograph is taken In this system, the processing is carried out b feeding the negative and the printing paper betwee pressure rollers, the reagent being spread in th form of a viscous liquid between the negative an positive emulsions (*J. Opt. Soc. Amer.*, **37**, 61 1947).

National Geographic Magazine and Dr. Gilber Grosvenor

DR. GILBERT GROSVENOR, president of the Nationa Geographic Society of Washington, D.C., was presented with a medal named after him at a ceremon on May 17, to mark his completing half a century a editor of the *National Geographic Magazine*. Th *Magazine*, which is really of his making, now has circulation of about two million copies a month. I was in 1899 that the President of the Society at th time was concerned about its official organ, whic had only a trivial circulation and no funds behind it The president in those days, who was A. Graham Bell, of telephone fame, appointed as editor o the *Magazine* a young, untried, but not untravelled man. Since then Dr. Grosvenor has built up th reputation and circulation of this finely illustrate journal, which is known throughout the world fo the excellence of its photographic illustrations and it colour plates. After five or six precarious years, th corner was turned about 1905 and the circulatio steadily grew. Dr. Grosvenor has collected photographs from every corner of the globe and articles b many eminent travellers. He has also edited a serie of large-scale detailed political maps issued with th *Magazine* from time to time, which have a wid circulation and use, and are notable for their accuracy The profits of this successful publication have bee largely devoted to exploration and research in variou lands and seas.

Marine Biological Station at Bangor: Dr. F. Gross

Dr. Fabius Gross, who has since 1937 been lecturer in experimental zoology in the University of Edinburgh, has been appointed director of the new Marine Biological Station to be erected on the Menai Strait at Bangor. The Station, while under the immediate control of the University College of North Wales, will be managed by a committee representing the biological departments of the constituent colleges of the University of Wales, and it is likely to become a vital link in the chain of British marine stations. Apart from its function in promoting educational facilities for the students of the University and others, it will conduct and encourage research, particularly in the almost unexplored field of marine microbiology, in which botanical and zoological studies meet. It will thus be in a position to make great contributions to fundamental knowledge as well as to the practical basis of fishery research, for there can be little doubt that the food-chains which ultimately produce our fish stocks have their biological origin in the microplankton.

Dr. Gross is eminently qualified to direct the work of the Station. His zoological studies in the University of Vienna under Profs. Storch, Versluys, Przibram and Joseph, and his researches there and in the Kaiser Wilhelm Institut für Biologie in Berlin, laid the foundation for experimental investigations of feeding, swimming movements, variation and regeneration in various aquatic invertebrates. Since he came to Britain in 1933, he has turned his attention particularly to culture methods for marine organisms, and this led to the war-time research, conducted by a team partly from the Department of Zoology in the University of Edinburgh and from Millport Marine Station, into the effect upon food-chains culminating in food fishes of the addition of inorganic nutrients to restricted sea areas. His extensive experience of British marine stations has been supplemented by large-scale plankton culture at the Oceanographic Institute at Göteborg in Sweden, and he has been invited to spend the present summer in collaborative work at the Oceanographical Laboratory at Woods Hole.

Linnean Society of London

Prof. Otto Jaag, of the Federal Technical High-school, Zurich, and Dr. David Fairchild, senior agricultural explorer to the U.S. Department of Agriculture, have been elected foreign members of the Linnean Society. Prof. Jaag is distinguished for his researches in limnology, and is editor of the *Schweizerische Zeitschrift für Hydrologie*. Dr. Fairchild, now eighty years of age, is distinguished for his labours in botany in its relation to horticulture. He has introduced many thousands of useful and ornamental plants into the United States. As an author, in addition to his scientific papers, he has published five books dealing with his travels in search of plants.

Two new associates *honoris causa*, the list of whom has never exceeded twenty-five, have also been elected by the Linnean Society; they are Dr. Robert Lloyd Praeger, of Dublin, distinguished for his long and thorough work on the flora of Ireland, and for his monographs of *Sedum* and *Sempervivum*; and Dr. Arvid Hjalmar Uggla, of Uppsala, distinguished for his researches on the work, writings and life of Linnæus. Dr. Uggla is the secretary of the Svenska Linné-sällskapet and editor of that Society's *Årsskrift*; and is at present working on a complete catalogue of the known manuscripts of Linnæus.

Disk for the Isaac Newton Telescope

Sir Harold Spencer Jones, Astronomer Royal, has recently spent three months in the United States, at the invitation of many American astronomers, in the course of which he visited most of the astronomical observatories, studying programmes of work and, in particular, the design and performance of large telescopes in connexion with the design, now under consideration, of the Isaac Newton reflector. During his visit he received the gift of a 98-in. 'Pyrex' glass disk for use in this telescope. The disk, which was cast before the War by the Corning Glass Co., was originally intended for use in a large reflector for the Michigan Observatory, a project which for various reasons was later abandoned. Its cost had been defrayed from the McGregor Fund. Judge Henry Hulbert, president of the Trustees of the McGregor Fund, informed the Astronomer Royal that the Trustees had unanimously resolved to make an outright gift of the disk, together with a 26½-in. disk for a secondary mirror and the central plug from the large disk, to the Royal Greenwich Observatory, for use in the Isaac Newton telescope. This generous gift, which has been gratefully accepted, should enable the telescope to be completed and brought into use some two or three years before it would otherwise have been possible. It is a symbol of the good-will on the part of the United States towards Great Britain, which the Astronomer Royal found everywhere in the course of his visit, and of the desire for close co-operation between the astronomers of the two countries.

Gamma-emitting Materials for Industry

A preliminary announcement has already been made by the Ministry of Supply on the sale of radioactive products for industrial radiography (see *Nature*, May 7, p. 717). A paper dealing with the supply and uses of radium and radon for industry is now being distributed by the Ministry to trade associations, professional institutes and research centres. Points of interest arising from this paper are the different physical properties of radium and radon. Though they both emit gamma-rays of identical quality, the radiation of the former is constant, whereas that of the latter has a half-life period of 3·8 days. This means that the effective life of radon is a little more than a week, but this is an advantage in, say, field-work where the loss of a capsule would not be serious, nor comparatively dangerous (in contrast to radium). The disadvantage of the variable strength of radon is further offset by the fact that, for equal intensities, it is of much smaller bulk than radium; hence, for radiographs of equal resolution, radon can be used much closer to the object under test, with a corresponding reduction in exposure-time. Radium may be obtained, on hire only and after notice of two months, for periods of not less than six months; capsules containing 50 mgm. and 250 mgm. are hired for £11 5*s*. and £56 5*s*. per year, with an additional fabrication and testing charge of £20 and £100, respectively. Radon is sold outright, typical costs being £15, £20 and £25 for sources of 250, 500 and 750 millicuries, respectively. Both materials can be obtained from the Radiochemical Centre, White Lion Road, Amersham, Bucks. Gamma-radiography requires skilled personnel for the handling of materials, interpretation of radiographs, etc., and, so far as is known, the only institution in Britain at present offering training facilities is the Kodak School of Engineering Radiography, Wealdstone, Harrow, Middlesex. Advice on the use of gamma-radiography (demonstrations are given) may be obtained from the Superintendent of Radiology Research, Ministry of Supply, Armament Research Establishment, Woolwich, London, S.E.18, and also from the Director, National Physical Laboratory, Teddington, Middlesex.

Gasteromycetes of Greenland

MORTEN LANGE has published a critical survey of the Gasteromycetes found in Greenland prior to the expedition of 1946 (*Medd. Grønland*, 147, No. 4, pp. 32+4 pl. København: C. A. Reitzels Forlag, 1948. Kr. 2.00). Thirteen species are described in detail. Most of them have European or North American affinities, though *Calvatia tatrensis* var. *groenlandica* is practically confined to Greenland. Some earlier records are reviewed, and their naming compared with modern standards.

University of Birmingham: Appointments

THE following announcements have been recently made in the University of Birmingham. The title of reader in renal physiology has been conferred on J. A. Barclay, lecturer in physiology. *Appointments:* F. J. Dyson to be research fellow in mathematical physics; J. T. Allanson to be lecturer in electrical engineering; B. H. Pethica to be lecturer in pharmacology; R. J. Boscott to be lecturer in endocrine chemistry. *Resignations:* Dr. H. B. Whittington, lecturer in geology, on appointment as visiting lecturer in geology at Harvard University; C. D. Cruikshank, lecturer in bacteriology, on appointment as assistant pathologist at the Selly Oak Hospital; S. Harper, lecturer in metallurgy, on appointment as research fellow at the University of Chicago; M. A. Preston, assistant lecturer in mathematical physics, on appointment as assistant professor in the Department of Physics, University of Toronto; P. L. Adams, lecturer in mining, on appointment as senior lecturer in charge of mining in the University of Sydney; S. R. Cornick, a member of the physics technical staff for thirty years and steward of the Department since 1937, on appointment as chief technical officer to the Australian National University at Canberra.

Institute of Metals

THE Institute of Metals has appointed the following to be honorary corresponding members for their respective countries: *Spain*, Prof. J. Orland, professor and chief of the Department of Metallography and Strength of Materials, Instituto Católico de Artes e Industrias, Madrid; *Sweden*, Prof. A. G. E. Hultgren, professor of metallography, Tekniska Högskolan, Stockholm; *United States*, Prof. R. F. Mehl, director of the Metals Research Laboratory and head of the Department of Metallurgical Engineering, Carnegie Institute of Technology, Pittsburgh, and Dr. R. A. Wilkins, vice-president (research and development), Revere Copper and Brass, Inc., Rome, N.Y.

Royal Aeronautical Society

THE Council of the Royal Aeronautical Society for the year 1949–50 has been announced as follows: *President*, Sir John S. Buchanan; *Past Presidents*, Dr. H. Roxbee Cox, Sir Frederick Handley Page; *Vice-Presidents*, Mr. W. G. A. Perring, Mr. N. E. Rowe, Dr. H. C. Watts; *Council Members*, Lord Brabazon of Tara, Major G. P. Bulman, Mr. S. Camm, Mr. A. V. Cleaver, Dr. G. P. Douglas, Mr. G. R. Edwards, Mr. A. G. Elliott, Mr. W. S. Farren, Sir A. H. Roy Fedden, Sir Arthur Gouge, Major F. B. Halford, Prof. A. A. Hall, Mr. S. Scott Hall, Mr. J. W. F. Housego, Mr. P. G. Masefield, Mr. W. Tye, Capt. C. F. Uwins; *Honorary Librarian*, Mr. J. E. Hodgson; *Honorary Treasurer*, Capt. C. F. Uwins; *Solicitor*, Mr. L. A. Wingfield; *Secretary*, Capt. J. Laurence Pritchard.

Announcements

PROF. H. P. HIMSWORTH has been appointed by the Medical Research Council to be its secretary in succession to Sir Edward Mellanby, who retires on October 1. Dr. Himsworth is at present professor of medicine in the University of London and director of the Medical Unit at University College Hospital; he has been a member of the Council since February 1948.

THE Thomas Young Oration for 1949 of the Physical Society will be delivered by Mr. T. Smith on June 10; he will take as his subject "The Contributions of Thomas Young to Geometrical Optics, and their Application to Present-day Questions".

THE Royal Astronomical Society is arranging meetings to be held during June 30–July 2 in Manchester, in co-operation with the University of Manchester and the Manchester Astronomical Society. The programme includes a public lecture at the University, to be given by Dr. M. A. Ellison, of the Royal Observatory, Edinburgh, on "Sun, Radio and the Stars", on June 30; a visit to Jodrell Bank Experimental Station on the morning of July 1, followed by an ordinary meeting of the Royal Astronomical Society, and a dinner given by the Vice-Chancellor of the University; and a Geophysical Discussion on "Ionization in the Earth's Upper Atmosphere", to be held on July 2. Further information can be obtained from the Assistant Secretary, Royal Astronomical Society, Burlington House, London, W.1.

A CONFERENCE on "The Properties of Semi-Conducting Materials" is to be held at the University of Reading during July 11–14, 1950. The conference will be sponsored by the International Union of Physics, in co-operation with the Council of the Royal Society. It is hoped that papers will be read by prominent representatives from the United States and European countries. Details will be published later.

THE Royal Aeronautical Society announces that a scholarship to be known as the Royal Aeronautical Society Charter Scholarship, up to the value of £300 a year, will be awarded annually to assist a student wishing to undertake advanced work or study in aeronautics. Normally, the work should lead to a higher degree or postgraduate diploma, although this is not essential. Scholarships will in the first instance be awarded for a period of one year. Applications should reach the Secretary of the Society not later than June 30, stating the course it is intended to follow.

ERRATUM. In *Nature* of May 28, p. 833, it was stated that a summer school on electron microscopy will be held at the Cavendish Laboratory, Cambridge; the dates for this school are August 16–27.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

High-Energy Electron Accelerators as Pulsed Neutron Sources

In the time-of-flight method of distinguishing between neutrons of different energies, various types of pulsed neutron sources have been used. So far, however, the use of pulsed sources of high-energy electrons for generating neutrons through the (γ, n) reaction has not been reported. Experiments reported in the following letter show that the X-rays from a 3- or 4-MeV. linear accelerator will produce useful intensities of neutrons from a beryllium target.

From these results it would appear that a 10-MeV. linear accelerator would provide a suitable source.

By such means, time-of-flight measurements could be made with reasonable resolutions up to energies hitherto unobtainable.

J. D. Cockcroft

In the preceding letter, Sir John Cockcroft discusses the possibility of using high-energy electron accelerators as pulsed neutron sources. To investigate the potentialities of the method, measurements have been made on the linear electron accelerator at this Establishment[1]. An experiment was performed when the accelerator was providing 100 m.amp. peak current in a 2-μsec. pulse of electrons of energy 3·2 MeV. The electrons were absorbed in a lead target, and the resulting X-radiation was absorbed in a container about 13 in. long (in the direction of the beam) and 5 in. square. The container was filled either with heavy water or with beryllium scraps, the latter giving a density of about 0·7 gm./c.c. The neutrons produced were absorbed in manganese sulphate solution in a tank surrounding the container. The neutron production was measured by comparing the activity of the manganese solution with that produced by a 200-mgm. radium – beryllium source inserted in place of the container.

Under these conditions, calculations based on the Bethe – Heitler theory of X-ray production from electrons predict a peak neutron production in the pulse of about 3×10^{12} neutrons per sec. (for heavy-water target). The experimentally determined value was $2 \times 10^{12} \pm 25$ per cent neutrons per second, the error being due partly to uncertain calibration of the radium – beryllium source and partly to uncertainties in the comparative geometry in the main and calibration runs. The beryllium target gave a neutron production 30 per cent lower than that from the heavy water.

It is apparent, therefore, that this method holds great promise for time-of-flight measurements. With higher energy linear accelerators, measurements with good resolution up to neutron energies of 20 keV. or more should be possible. Moreover, the high electron currents available at low pulsing-rates on machines using Marx-type generators might provide neutron sources of sufficient strength to work up into the 100-keV. region. The low pulse-rate would be a disadvantage, but measurements would be possible using very long time-of-flight paths, or, alternatively, a shorter path coupled with a short pulse and a high-resolution detector.

J. C. Duckworth
A. W. Merrison

Atomic Energy Research Establishment,
Harwell, Didcot,
Berks.
April 6.

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[1] *Nature*, **160**, 351 (1947).

Effect of X-Rays on the Incorporation of Carbon-14 into Desoxyribonucleic Acid

It was observed by several experimenters[1] that the incorporation of phosphorus-32 into desoxyribonucleic acid of the Jensen sarcoma, and also of normal organs, of the rat is markedly reduced by irradiation with an X-ray dose of some hundred röntgens. This result strongly suggests the explanation that the rate of formation of desoxyribonucleic acid is reduced by the effect of ionizing radiation, though the objection may be raised that it is the re-phosphorylation of the molecule during incorporation of labelled phosphate which is hampered, and not the formation or the assembly of the main constituents of the nucleic acid molecule. To avoid this objection, the effect of X-rays on the incorporation of carbon-14 into the purines of desoxyribonucleic acid in the organs of rapidly growing rats has been studied.

About five microcuries of carbon-14 incorporated with the carboxyl group of sodium acetate were injected subcutaneously to each of 91 one- to three-week-old rats. The rats were killed after the lapse of six hours, and the desoxyribonucleotides were separated from the proteins by extraction with hot trichloroacetic acid[2]; the purines obtained by hydrolysis were twice precipitated as silver salts and their radioactivity was measured. Previous to the extraction of the kidney and muscle proteins, 20 mgm. of desoxyribonucleic acid, kindly presented by Prof. Hammarsten, were added to the trichloroacetic acid extract. Half the rats were previously irradiated with a dose of 950 r., the voltage applied being 165 kV.

As shown by the figures in the accompanying table, the amount of labelled purines formed in the irradiated rats was about half the amount formed in the con-

Ratio of carbon-14 content of 1 mgm. of purine isolated from desoxyribonucleic acid of non-irradiated and irradiated rats six hours after administration of about 0·4 mgm. of labelled carbon as acetate to each of 91 one- to three-week-old rats

Organ	Ratio of C^{14} content of purine from desoxyribonucleic acid isolated from non-irradiated and irradiated rats, respectively				Ratio of C^{14} content of 1 mgm. protein from organs of non-irradiated and irradiated rats, respectively		
	Group 1	Group 2	Group 3	Group 4	Group 2	Group 3	Group 4
Intestinal mucosa	2·3	2·0	2·2	1·5	0·78	0·80	0·90
Liver	2·3	2·0	1·5	1·5		0·83	0·50
Muscles			3·1	1·8		0·91	1·0
Kidneys	1·0		3·0	3·7		1·0	1·0

Percentage of administered C^{14} incorporated in 1 mgm. intestinal mucosa

	Purine min.	Purine max.	Protein min.	Protein max.
Non-irradiated	$3 \cdot 7 \times 10^{-5}$	$2 \cdot 4 \times 10^{-4}$	$4 \cdot 1 \times 10^{-4}$	$6 \cdot 3 \times 10^{-4}$
Irradiated	$1 \cdot 7 \times 10^{-5}$	$1 \cdot 3 \times 10^{-4}$	$5 \cdot 2 \times 10^{-4}$	$7 \cdot 8 \times 10^{-4}$

trols, which is very similar to the reduction in the incorporation of phosphorus-32 observed earlier[1].

The rate of incorporation of carbon-14 into the proteins was not reduced by irradiation; even some increase was observed, which may be due to a decrease in the metabolic-rate produced by irradiation and leading to an increased level of carbon-14 in the liver and intestinal mucosa, corresponding to a greater incorporation of carbon-14 into the proteins of these organs. The fact that, despite the increased carbon-14 content of the proteins of the irradiated rat, we observed a markedly reduced incorporation of carbon-14 into the purines of desoxyribonucleic acid of such rats clearly indicates a reduced rate of formation of the last-mentioned compound in the irradiated animal. The observation that the rate of formation of a main constituent of cell nuclei is reduced appreciably after irradiation helps to explain the blocking effect of irradiation on cell division and the formation of anomalous mitotic products in the irradiated tissue.

In this connexion it may be of interest to recall that the hypothesis of nucleic acid starvation was recently put forward by Darlington[3], who assumes the chromosomes to vary in their behaviour and appearance according to nucleic acid supply available.

My thanks are due to Miss G. Dreyfus for very effective assistance.

G. HEVESY

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Stockholm.

March 25.

[1] A survey of earlier work has been given by Hevesy, G., *Rev. Mod. Phys.*, **17**, 102 (1945). See also Jones, H. B., personal communication (1946). Mitchell, J. S., and Holmes, B. E., Ann. Rep. British Empire Cancer Campaign, 136 (1947). Holmes, B. E., *Brit. J. Radiol.*, **20**, 450 (1947).

[2] Schneider, W. C., *J. Biol. Chem.*, **161**, 293 (1945).

[3] Darlington, C. D., Symp. Soc. Exp. Biol., 1, 252 (Cambridge Univ. Press, 1947).

Surface Transport of Liquid Helium II

RECENTLY, Atkins[1] has reported transport-rates in helium films which were many times greater than those observed under somewhat similar conditions by J. G. Daunt and one of us[2]. Moreover, these rates were not constant, as in our experiments, but evidently varied in a complex manner with the length of the film. Atkins used glass beakers which, in contradistinction to our original experiments, ended in a large bulb. He ascribed the phenomena observed by him as being due to the geometrical arrangement and connected with the temperature gradient in the film, supporting this suggestion by a separate experiment. Lately, de Haas and van den Berg[3] have also observed such high transfer-rates. It appears that there was no temperature gradient in their experiment, and they attribute the high rate to the complete absence of incident radiation.

A systematic study of the factors affecting the film transfer has been in progress in this Laboratory for more than two years, and it may therefore be of interest to compare our results with the above-mentioned observations. First, we have found *no* indication that high transport-rates are caused by a temperature gradient[4]. Secondly, we found that the transfer-rate of a narrow beaker was *unchanged* after a bulb had been attached to it. Thirdly, we found that the transfer-rate remained *unchanged* even when radiation was excluded completely.

It thus appears that beside the frictionless film transfer with a maximum transport-rate of about 10^{-4} cm.^{3}/cm./sec., which has consistently been observed by us in well over a hundred individual experiments, there can occur occasionally a surface flow reaching much higher rates and of more complex aspect. However, the curious fact remained that our results differ from those of Atkins and the Leyden workers, although our experimental arrangements conformed with the conditions postulated by these authors as causing high rates of flow. This seemed to indicate that the real reason for the appearance of high flow-rates has to be sought in some subtle difference in experimental technique. Observations by J. O. Closs and one of us[5] of a desorption of helium layers, probably akin to the film later discovered by Rollin and Simon[6], already showed the strong dependence of this desorption on the state of the surface. A careful analysis of all experiments in which a high transfer-rate seems to have occurred suggested to us that the real cause of this effect might be found in the condition of the solid surface carrying the transfer, and in particular in the contamination with condensed gases. In order to investigate this point, we carried out a standard transfer experiment with a cylindrical glass beaker, out of which helium flowed into the surrounding bath. The rate of transfer was again found to be in good agreement with our previous work. Then some helium gas containing a small amount of air was introduced into the cryostat, and a thin layer of solid air was deposited on the beaker. A repetition of the previous experiment showed that the character of the transfer had now completely changed. The initial transport-rate had increased about ten times, and varied with the distance of the higher level from the rim of the beaker, as observed by Atkins. Subsequent observations have shown that: (1) On depositing successive thin layers of solid air, the transfer changes gradually from the normal type to that observed in Cambridge and Leyden. (2) Beyond a certain thickness of the layer of solid air, the transfer does not increase with further deposition. (3) The layers of solid air up to the thickness which gives the saturation transport-rate are completely transparent and colourless. The appearance of still thicker layers suggests that the deposit is granular with a grain-size of the order of the wave-length of light. (4) An adsorbed layer of air deposited on the glass surface at 90° K. slightly increases the transport-rate.

These results, together with our inability to obtain high transport-rates in the earlier experiments, seem to leave no doubt that the phenomena observed in Cambridge and Leyden are entirely due to contamination of the surfaces employed and have, to some extent, lost the character of pure film transfer. While thus, in our opinion, these high transport-rates are spurious effects which may be difficult to interpret in a quantitative manner, the phenomenon is of considerable importance for cryogenic technique. We observed that after the introduction of impure helium which had deposited a layer of solid air, not only on the beaker, but also on the walls of the cryostat and the pumping tube, the evaporation of helium was greatly increased owing to the higher transfer along the walls. Clearly, the recognition of the real cause of high transport-rates and its avoidance is of particular importance for experiments below 1° K.[7]. A letailed discussion of our experiments and their mplications will be published elsewhere.

R. Bowers
K. Mendelssohn

Clarendon Laboratory,
Oxford.
May 9.

[1] Atkins, K. R., *Nature*, **161**, 925 (1948).

[2] Daunt, J. G., and Mendelssohn, K., *Proc. Roy. Soc.*, A, **170**, 423 (1939); *Nature*, **143**, 719 (1939); *ibid.*, **157**, 839 (1946).

[3] de Haas, W. J., and van den Berg, G. J., to be published shortly; private communication.

[4] Brown, J. B., and Mendelssohn, K., to be published shortly; Brown, J. B., thesis (Oxford, 1949).

[5] Mendelssohn, K., and Closs, J. O., *Z. phys. Chem.*, B, **19**, 291 (1932).

[6] Rollin, B. V., and Simon, F., *Physica*, **6**, 219 (1939).

[7] Blaisse, B. S., Cooke, A. H., and Hull, R. A., *Physica*, **6**, 231 (1939).

Strengths of Metals

No experimental method has been suggested for recording directly the pure diffraction broadenings of X-ray reflexions; there is always an appreciable amount of broadening due to experimental conditions, and the diffraction broadening has to be disentangled from the total broadening by various procedures[1,2]. In any statement of results, therefore, it is essential that the particular procedure used should be stated, so that even if other workers think it unsatisfactory they should at least have some basis for comparison with their own results.

Wood and Rachinger do not give such experimental details in the results they have recently published[3]. In re-stating the claim that the broadening of X-ray reflexions from cold-worked metals is due to the smallness of the crystallites into which the grains are broken, they make no reference to our critical comments[4] on evidence previously given[5] in support of this claim, nor to the considerable amount of experimental work[6–9] which points to inhomogeneous internal strains as the principal cause of the broadening.

There still remains, however, the striking agreement obtained for the yield stresses of a number of metals when the values of Wood's 'limiting crystallite size' are substituted in the expression that Bragg[10] has derived theoretically. The main purpose of this present communication is to show that this agreement results also from the theory that the broadening of the reflexions is due to inhomogeneous internal stresses, the argument being as follows.

Wood's 'limiting crystallite size' t may be regarded as a parameter related to the broadening β by the relation

$$t = \lambda/\beta \cos\theta, \tag{1}$$

where λ is the wave-length of the radiation, and θ is the Bragg angle. (In effect, this is Wood's original definition, but the unfortunate name he proposed for the parameter has been the cause of much misconception.) In Bragg's theory of the strength of metals[10], it is shown that the yield stress Y should be related to the true crystallite size t_c by the expression

$$Y = ns/t_c, \tag{2}$$

where n is the rigidity and s is the atomic diameter. If Wood's values for t are substituted for t_c, Bragg showed that the correct order of magnitude for Y is given for a number of metals.

Combining equations (1) and (2), we have

$$Y = ns\beta \cos\theta/\lambda. \tag{3}$$

Now, according to Stokes, Pascoe and Lipson[7], the yield stress should be related to β by the expression

$$Y = E\beta \cot\theta, \tag{4}$$

where E is Young's modulus, which for the present purpose may be regarded as constant.

Equations (3) and (4) may be written as

$$\left.\begin{aligned} Y &= \frac{ns}{\lambda}\,\beta\cos\theta \\ \text{and } Y &= \frac{E}{\sin\theta}\,\beta\cos\theta \end{aligned}\right\} \tag{5}$$

and it can be shown that ns/λ and $E/\sin\theta$ are approximately equal for the conditions of Wood's experiments.

The ratio of these quantities is

$$\frac{ns\sin\theta}{E\lambda} = \frac{1}{2(1+\sigma)}\,\frac{s}{\lambda}\sin\theta, \tag{6}$$

where σ is Poisson's ratio. Sin θ is almost exactly unity, because Wood uses only the back reflexions, and, since $\sigma \simeq 0{\cdot}3$,

$$\frac{ns\sin\theta}{E\lambda} \simeq 0{\cdot}4\,\frac{s}{\lambda}. \tag{7}$$

For most of the metals considered, $s \simeq 2{\cdot}5$ A., but λ, of course, is different for different radiations. We may, however, take the two radiations quoted by Wood[5] as examples; for cobalt $K\alpha$, $0{\cdot}4s/\lambda \simeq 0{\cdot}55$, and for molybdenum $K\alpha$, $0{\cdot}4s/\lambda \simeq 1{\cdot}4$. Thus the coefficients of equations (5) are approximately equal, and approximately correct values of Y follow from either of them.

In order to distinguish between the two equations, qualitative work is useless; quantitative results, for the variation of β with both θ and λ, are necessary, and we believe that these results have already been produced in the papers quoted in this communication.

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Department of Physics,
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A. R. Stokes

Wheatstone Physics Laboratory,
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[1] Jones, *Proc. Roy. Soc.*, A, **166**, 16 (1938).

[2] Stokes, *Proc. Phys. Soc.*, **61**, 382 (1948).

[3] Wood and Rachinger, *Nature*, **162**, 891 (1948).

[4] Lipson and Stokes, *Nature*, **152**, 20 (1943).

[5] Wood, *Nature*, **151**, 585 (1943).

[6] Brindley, *Proc. Phys. Soc.*, **52**, 117 (1940).

[7] Stokes, Pascoe and Lipson, *Nature*, **151**, 137 (1943).

[8] Smith and Stickley, *Phys. Rev.*, **64**, 191 (1943).

[9] Megaw and Stokes, *J. Inst. Metals*, **71**, 279 (1945).

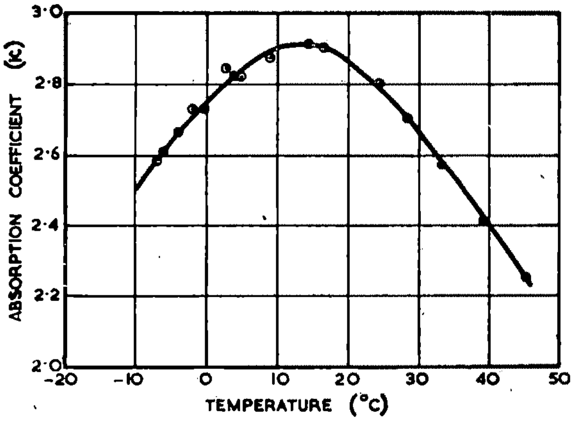
[10] Bragg, *Nature*, **149**, 511 (1942).

Absorption of 12·5-mm. Wave-length Electromagnetic Radiation in Supercooled Water

We have recently succeeded in measuring the absorption of radio waves of wave-length 12·5 mm. in transmission through water in the supercooled state in layers of varying thickness up to several millimetres: the lowest water temperature so far reached in this work is − 7° C.

The complex refractive index of an absorbing medium may be expressed as $(n - j\varkappa)$, and our measurements have led to a determination of the absorption coefficient $\varkappa$. It is well known that if such an absorbing medium is inserted in a wave-guide, completely filling it over a portion of its length, the rate of attenuation of waves passing through the medium is, in general, dependent both upon $\varkappa$ and upon the refractive index n. If the lateral dimensions of the wave-guide are sufficiently great, however, it may be shown that the absorption coefficient determined by measuring the rate of attenuation in a system such as this differs by a negligible amount from the value of $\varkappa$ pertaining to a medium of infinite extent. We have used this method, the diameter of the cylindrical wave-guide concerned being 24 mm.; such a diameter is quite adequate to yield the 'infinite medium' value of $\varkappa$ at a wave-length of 12·5 mm. After transmission through the water layer, the energy was picked up in a narrow cylindrical wave-guide probe filled with polythene, of dimensions such as to restrict the propagation to that of the H_{11} mode; the probe was driven by a micrometer, so that its location in the water was accurately known.

It is very difficult to maintain liquid water in a markedly supercooled condition, no matter how pure it may be, except when in contact with quite a restricted range of materials, one of which is glass. No success was achieved in the present series of experiments until the wide wave-guide was lined inside with a thoroughly cleaned thin-walled glass tube, and until the probe wave-guide was similarly covered with a thin-walled clean glass sheath. It was established, by making comparative measurements at temperatures above 0° C., that the introduction of these pieces of glass made no difference to the measured absorption coefficient. The temperature of the water was determined by a calibrated thermocouple inserted between the outer wall of the probe wave-guide and its glass sheath. The observed values of $\varkappa$ over the temperature range $-$ 7° C. to 46° C. are shown in the accompanying graph.



Absorption coefficient of pure water as a function of temperature and for a wave-length of 12·5 mm.

It will be seen that the absorption coefficient varies in a completely continuous manner as the temperature of the water passes through 0° C. The absorption mechanism in water, which is a pure polar liquid, is that associated with dipolar dispersion, and it has been shown[1] that a close relation exists between the relaxation time of the polar water molecule and the viscosity of water, though not quite of the simple form originally suggested by Debye[2]. Since it is known[3] that the viscosity varies continuously through 0° C. down to $-$ 9·6° C., it is therefore not surprising that the absorption coefficient exhibits similar characteristics. A detailed description of this work will be published elsewhere later, together with an account of similar measurements at other wave-lengths.

The work described above was carried out as part of the programme of the Radio Research Board. This paper is published by permission of the Department of Scientific and Industrial Research.

J. A. Saxton
J. A. Lane

National Physical Laboratory,
Teddington. Nov. 30.

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[1] Saxton, J. A., "Meteorological Factors in Radio Wave Propagation", 306 (Physical Society, 1946).

[2] Debye, P., "Polar Molecules" (New York: The Chemical Catalog Co., Inc.).

[3] Coe, J. R., and Godfrey, T. B., *J. App. Phys.*, 15, 625 (1944).

A Photo-electric Wool Staplemeter

The possibility of constructing a photo-electric apparatus capable of measuring the variations in fibre-length and diameter, and hence of 'tippiness' and 'break' in wool staples, has been exercising the mind of one of us (H. G.) for some time past, but only after reading a recent paper by Lord[1] were steps taken towards its realization. An experimental model, constructed by the other (R. E. B.), was ready in December 1947. In this model, the wool staple, after it has been prepared as described below, is laid lengthwise under a sheet of glass on an optically black tray (Fig. 1). The tray is capable of moving between two guides along the floor of a light-tight compartment of the apparatus. A 100-watt pearl lamp illuminates a narrow rectangular slit which is focused by means of a cylindrical lens to produce, on the tray top and at right-angles to its motion, a narrow rectangular light image approximately ⅛ in. wide and 3 in. long. The scattered light from the wool is measured by means of a photo-cell which is located directly above the light image. This cell is connected to a direct-current amplifier[2] the output of which is noted on a 0–50 micro-ammeter.

The meter reading (after the zero adjustment operation has been completed) is approximately proportional to the intensity of the light falling upon the cathode of the photo-cell and is thus dependent upon the light scattered by the wool fibres. This in turn is proportional to the number of fibres, their cross-section and, to a minor degree, the nature of the scattering surface.

The aim of the preliminary investigation, on which this account is based, was to ascertain the relationship between the photo-electric reading in microamperes and the number of fibres counted at the level at which each of the readings was taken. For this purpose twenty-eight wool samples of the same count

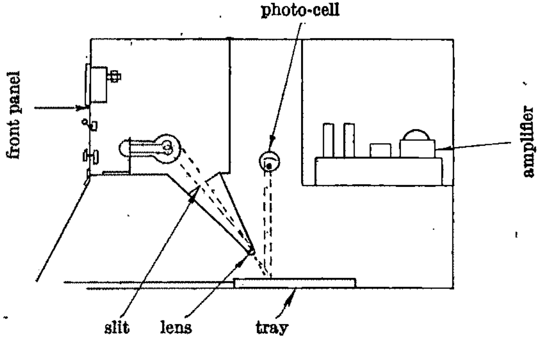

Fig. 1. General arrangement

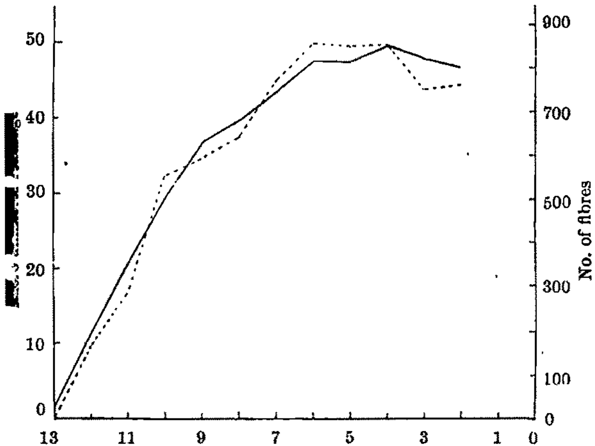

Fig. 2. Full line, number of fibres; broken line, micro-ammeter readings

50's) and practically free of hairiness[3] were taken from New Zealand Romney Marsh unshorn (that is, not shorn as lambs) hoggets[4]. The following testing procedure has been adopted: a small sub-sample is pulled from the staple, secured in a clip at the base of the staple, and washed in benzol. When dry, it is spaced on the staplemeter clamp and teased while hanging perpendicularly. It is then transferred to the staplemeter tray, covered with the cover-glass and the micro-ammeter reading recorded at centimetre intervals. For the purpose of counting the fibres, the sub-sample is cut at centimetre intervals to correspond with the points at which the micro-ammeter readings are taken.

The twenty-eight intra-staple correlation coefficients between the micro-ammeter readings and the number of fibres thus computed proved to be statistically highly significant; their values ranged from $r = 0 \cdot 943$ to $r = 0 \cdot 994$ with 9–16 degrees of freedom. Similarly, the correlation coefficient, based on all measurements in twenty-eight samples, $r = 0 \cdot 955$ with 414 degrees of freedom, is very satisfactory, and the coefficient of regression indicates that one unit of the micro-ammeter equals twenty fibres of 50's count on the average.

Fig. 2 gives what probably is a typical example of the relationship between the micro-ammeter readings and number of fibres.

Thanks of one of the writers (H. G.) are due to Dr. E. R. Cooper, director of the Dominion Physical Laboratory, for lending the experimental model for the duration of the experiment, and to Mr. E. A. Clarke, head of the Sheep and Wool Department, Massey Agricultural College, for encouragement and helpful advice; the other writer (R. E. B.) wishes to acknowledge helpful suggestions from Dr. A. G. Bogle, of the Dominion Physical Laboratory.

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Drug-Resistance Shown by Trypanosomes Following 'Antrycide' Treatment

THE control of bovine trypanosomiasis by chemotherapy has recently received a welcome stimulus owing to the discovery of the trypanocidal properties of the new drug 'Antrycide'. The original investigators (Curd and Davy, 1949 [1]) have shown its curative and prophylactic action in experimental animals against several species of trypanosomes infecting man and cattle, and at Entebbe, Uganda, we have shown[2] that the soluble sulphate salt of 'Antrycide', in doses of 3–5 mgm. per kilo, cured *Trypanosoma simiæ* infections in pigs. One pig, however, infected with *T. simiæ* and dosed with the relatively insoluble chloride salt at 2 mgm. per kilo, relapsed. A second immediate treatment with 5 mgm. per kilo 'Antrycide' sulphate failed to cure this pig, and the relapse strain was considered, therefore, to have developed drug-resistance in this short time.

This question of drug-resistance will require careful investigation in the case of *Trypanosoma congolense* and *Trypanosoma vivax* infections in cattle. Experiments at Entebbe indicate that strains of trypanosomes found in re-infected animals after the first treatment with 'Antrycide' may have considerable resistance to further treatment. This is illustrated by an experiment in which ten cattle were dosed with 2 gm. each of 'Antrycide' sulphate and were then exposed to trypanosome infection in a *Glossina pallidipes* area. Only one was alive six months later, and a strain of *T. congolense* collected from this animal and sub-inoculated into a non-infected calf at the laboratory resisted treatment with 5 mgm. per kilo 'Antrycide' sulphate; and when six mice were infected with the same strain and treated with 10 mgm. per kilo 'Antrycide' sulphate, two of them relapsed 52 days later. A field strain collected in the same area from an untreated ox was cured with 'Antrycide' sulphate at 0·5 mgm. ger kilo.

In some cases, animals re-infected some months after treatment with 'Antrycide' and re-treated with curative doses of 'Antrycide' sulphate have developed cryptic but nevertheless fatal infections. Should such cryptic infections or prolonged latent infections prove to occur frequently after 'Antrycide' treatment, an accurate estimation of the true duration of the prophylactic effect will be difficult.

We have some evidence to show that *T. vivax* also quickly develops an appreciable degree of drug-resistance after treatment with 'Antrycide'.

Treatment with 1 mgm. per kilo dimidium bromide (phenanthridinium 1553) of relapse or re-infected strains of *T. congolense* following 'Antrycide' treatment has been unsuccessful, and it appears that strains resistant to 'Antrycide' are also resistant to curative doses of dimidium bromide.

In animals which have relapsed or become re-infected after treatment with 'Antrycide', a dose of 5 mgm. per kilo will not ensure sterilization of the infection in every case and may favour the development of drug-resistance, while a dose in excess of 10 mgm. per kilo can be toxic. The toxic symptoms sometimes develop quickly, the animal losing consciousness and dying two to six hours after treatment; in other cases a severe gastro-enteritis develops forty-eight hours after treatment, and death occurs between the sixth and twelfth days.

Drug resistance may be due to the elimination of the more susceptible trypanosomes with the consequent development over several generations of resistant strains, or possibly the drug may favour the development of resistant mutant strains. In either case, the early treatment of relapsed or re-infected cases before any marked change in the trypanosomes can be produced is obviously more likely to be successful. The limited experience we have had at Entebbe does support this contention. Repeated treatments in the field three to four times a year will, however, require careful planning, may prove expensive, and the ultimate success of such a procedure in tsetse areas still awaits proof.

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Influence of Streptomycin and Mineral Salts in the Action of Ribonuclease

The influence of streptomycin sulphate (Pfizer) and chloride (Ayerst) on the action of crystalline ribonuclease, prepared according to Kunitz[1], has been tested under the conditions indicated by Kunitz himself for the dosage of the activity of this enzyme.

The antibiotic was added to the fermentative system in the quantities required to attain concentrations decreasing from 1 : 1,000 to 1 : 10,000,000. As a substrate, a highly purified ribonucleic acid was used, which could be wholly precipitated by means of uranyl acetate in trichloracetic acid solution. Contrary to the observations of other authors[2], who have, in any event, worked under different conditions and employed different methods, inhibition of the action of the ribonuclease through the streptomycin was not observed.

Under the conditions in which our experiments took place, an increase of the activity of the enzyme was obtained, which at a 1 : 1,000 concentration of streptomycin reached an average increase of 50–60 per cent of the initial value. At a concentration of 1 : 10,000, the increase was 20 per cent on the average; and no change in comparison with the control could be observed by further dilution.

In order to investigate whether there is a relation between the power of streptomycin to precipitate the nucleic acids and its influence on the activity of the ribonuclease, the effect of soluble salts on such a precipitate was studied[3,4,5].

Sodium chloride and magnesium sulphate were used, and it was found that even in the absence of streptomycin, sodium chloride increases the effect of ribonuclease by about 60–65 per cent at a concentration of 0·45 per cent in the fermentative system. The effect resulting from the association of sodium chloride and streptomycin does not correspond to the addition of the effects of each substance taken separately. In fact, in a system containing streptomycin at a concentration of 1 : 1,000 and sodium chloride at a concentration of 0·45 per cent, an average increase of only 75 per cent is obtained.

Magnesium sulphate also shows an activating action on ribonuclease, greater than that of sodium chloride at the same concentration. Indeed, it produces an increase of 50–60 per cent at a concentration of 0·1 per cent, whereas at such a concentration sodium chloride is wholly ineffective.

The association of magnesium sulphate and stre mycin does not produce an effect correspondin the addition of both actions.

The effect of other substances on the actio ribonuclease is being studied. The results of studies will be published later, together with a tailed description of the method employed.

I wish to thank Miss Anna Spelta and Miss En Berti for their co-operation.

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Origin of Hyaluronidase in the Rat Te

Duran-Reynals[1] demonstrated that mammal testes contained a factor—the spreading facto which was capable of increasing the permeability the connective tissue. This observation has b confirmed by other investigators, and the factor been identified as the enzyme hyaluronidase. Spr *et al.*[2] showed that hyaluronidase was present testes from adult rats, but not in testes from fantile or cryptorchid rats. In their opinion, formation of hyaluronidase depended on compl spermatogenesis.

Eichenberger[3], Kurzrok *et al.*[4], and Werthesser *al.*[5] demonstrated a certain relation between content of hyaluronidase of human semen the number of spermatozoa, but were una to demonstrate any complete proportionality. It not ascertained at which stage of spermatogen the hyaluronidase was formed.

In order to find out at which time the hyaluronid is formed in the testis, I have examined testes fr rats of different ages, and the amount of hyaluronid has been compared with the histological pictu The testicular tissue was extracted with water, to ten times its own weight; the extraction t place at 4° C. and lasted twenty-four hours. Th the amount of hyaluronidase was determined by viscosimetric technique described by Riisfeldt[6], wh is a slight modification of the method of Hale[7]. T results are shown in the accompanying table.

No. of rat	Weight of one testis (mgm.)	Histological examination	Hyaluronidas content per gm. wet tissu (relative value
28	85	Only spermatogonia	0
29	83		
38	90	Spermatogonia and few spermatocytes	(+)
39	95		
45	160	Spermatogonia, many spermatocytes and ÷ spermatozoa	++
81	385	Spermatogonia, spermatocytes and ÷ spermatozoa	+++
27	520	Spermatogonia, spermatocytes, few spermatozoa	++++
106	1250	Adult rat with normal spermatogenesis	++++

It is thus possible to demonstrate considerable amounts of hyaluronidase in rat testes before spermatogenesis is complete. In No. 28, which contained spermatogonia only, it was impossible to demonstrate the presence of hyaluronidase in spite of the fact that a very concentrated testicular extract was used in the determination. In Nos. 28 and 29, owing to the small quantity of testicular tissue, the determination of hyaluronidase was performed on all four testes at the same time, after tissue for the histological examination had been removed. The same applies to Nos. 38 and 39, where it was found that the formation of spermatocytes had commenced, and here it was possible to show the presence of hyaluronidase, although only in a very slight amount. Not until in No. 45, where there were many spermatocytes, was it possible to show the presence of larger amounts of hyaluronidase. Also in No. 81, where the number of spermatocytes was still larger, considerable amounts of hyaluronidase could be demonstrated in spite of the fact that the spermatocytes had not yet been transformed into mature spermatozoa.

In No. 27 spermatogenesis was complete; but only a few spermatozoa were found at the histological examination. The largest amount of hyaluronidase was found here; but incidentally not much more than in No. 81, where the formation of mature spermatozoa had not begun.

Thus the content of hyaluronidase seems to increase with the number of spermatocytes.

In a large number of rats it was possible to show that the formation of hyaluronidase was very pronounced in testes before the spontaneous descent had occurred.

According to the investigations presented here, there seems to be no doubt that the formation of hyaluronidase in rats occurs at an early stage of the spermatogenesis, namely, before there are any mature spermatozoa, and that it is the spermatocytes that are responsible for the formation of hyaluronidase.

A detailed account of the present work will be published elsewhere.

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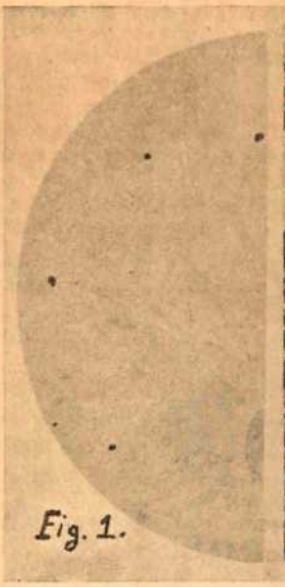
The Histochemical Test for Alkaline Phosphatase

WE should like to direct attention to the occurrence of a phenomenon of diffusion in the histochemical technique for the demonstration of alkaline phosphatase which makes precise localization of the enzyme difficult and is apt to produce errors in interpretation. With regard to such possible diffusion, two opposing views have been taken. Danielli[1], on the basis of specially designed experiments similar to, but not identical with, some of those to be reported here, has denied such diffusion (that is, of the reaction product) and declared the method as very reliable with regard to the localization of the enzyme. Lison[2], on the other hand, takes—at least with certain tissues—the occurrence of diffusion (that is, of enzyme) for granted and makes bad histological fixation responsible for it. There is abundant evidence in the literature in the form of photomicrographs, tabulated records, and descriptions of positive reactions given by cell constituents, especially nuclei, in the vicinity of regions of high phosphatase activity which makes the existence of diffusion as a complicating factor very likely; yet positive proof has so far been wanting. The following experiments seem to furnish such proof.



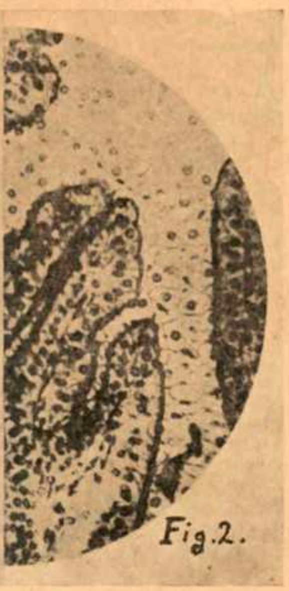


Fig. 1. Portion of guinea pig liver. Alkaline phosphatase reaction, 24-hr. incubation. Only a few phosphatase-positive cells in sinuses. Liver parenchyme negative. × 190

Fig. 2. Part of rabbit duodenum superimposed on guinea pig liver. Alkaline phosphatase reaction, 6-hr. incubation. Note: 'positive nuclear reaction' of the underlying liver cells with a decreasing gradient towards the top right, that is, away from the villi. × 190

(1) Frozen or paraffin sections of alcohol-fixed portions of small intestine or renal cortex (material with high phosphatase content) were superimposed on ready-mounted paraffin sections of alcohol-fixed guinea pig liver (material which for the present purpose can be regarded as phosphatase-negative[3] (Fig. 1)). Gomori's technique with and without added magnesium ions to the substrate mixture (sodium glycero-phosphate, pH 9·2–9·5) and with varying incubation periods was then applied. As a result, the nuclei of the underlying liver cells gave, sometimes as early as after $\frac{1}{2}$-hr. incubation, usually somewhat later, a positive reaction in regions that lay close to centres of high phosphatase activity of the superimposed section, with a gradient of diminishing 'staining' intensity away from these centres (Fig. 2). The degree of this 'positive nuclear reaction' in the underlying tissue is a function of the amount of active phosphatase in the overlying section and of the time of incubation.

(2) That diffusion also occurs within a section from foci of high phosphatase activity could be shown by excising a peripheral wedge, containing portions of Brunner's glands and adjacent muscle coats from a paraffin section of alcohol-fixed rabbit duodenum (previously tested and found to have a very high phosphatase activity), and treating this excised material simultaneously with, but on a different slide

from, the donor section according to Gomori's method. Whereas the latter—after 24-hr. incubation or even earlier—showed a widespread nuclear reaction including all the acini of Brunner's glands and most of the outer muscular coats, the excised wedge was found negative even after 72-hr. incubation.

There was no evidence of bad histological fixation. The diffusion occurs during the incubation period. Its duration is therefore of paramount importance and has to be carefully controlled for each tissue under investigation, for which purpose diffusion tests employing guinea pig liver as underlying material can be recommended.

Details of these and other experiments and a discussion of their implications will appear in the *Journal of Anatomy.*

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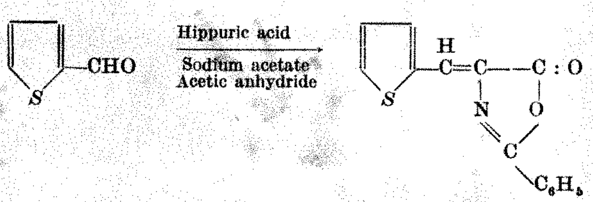
Syntheses of New Azlactones from Thiophene Aldehydes

In view of the availability of thiophene-2-aldehyde, 3-methylthiophene-2-aldehyde, 5-methylthiophene-2-aldehyde, 5-ethylthiophene-2-aldehyde, 5-propylthiophene-2-aldehyde, and 5-chlorothiophene-2-aldehyde[1], it was decided to prepare their azlactones, since these compounds serve as useful derivatives and intermediates for further syntheses.

The formation of these compounds proceeds as follows:



Using the procedure of Kropp and Decker[2], the compounds in the accompanying list were prepared.

Compound	Yield (%)	m.p. (° C.)	Analyses Calculated (%)	Analyses Found (%)
2-phenyl-4(2-thenal) 5-oxazolone[3]	68	174·5–175·5	C 65·88 H 3·53 N 5·49	C 66·1 H 3·66 N 5·69
2-phenyl-4(2-thenal 3-methyl)5-oxazolone	60	151–152	C 66·91 H 4·09 N 5·20	C 66·87 H 4·07 N 5·51
2-phenyl-4(2-thenal 5-methyl)5-oxazolone	58	152–153	C 66·91 H 4·09 N 5·20	C 67·00 H 3·94 N 5·40
2-phenyl-4(2-thenal 5-propyl)5-oxazolone	60	97–98·5	C 68·69 H 5·05 N 4·71	C 68·80 H 5·28 N 4·90
2-phenyl-4(2-thenal 5-ethyl)5-oxazolone	60	107·5–109	C 67·84 H 4·59 N 4·94	C 68·02 H 4·48 N 4·94
2-phenyl-4(2-thenal 5-chloro)5-oxazolone	61	182·5–183·5	C 58·03 H 2·76 N 4·83	C 58·40 H 2·74 N 5·19

All melting points are uncorrected.

Our studies include an extension of the reactions of unsaturated azlactones to the thiophene series as well as other syntheses of the rhodanine and hydantoin derivatives of thiophene aldehydes.

This investigation was carried out with the aid of a grant from the Office of Naval Research, and full details of it will be presented in due course elsewhere.

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Thermal Decomposition of Hydrogen Peroxide in the Vapour Phase

Baker and Ouellet[1] reported that when they boiled 98 per cent hydrogen peroxide solution at 100° C. and passed the vapour at pressures varying between 3 and 18 cm. of mercury through a wide 'Pyrex' tube heated to 335° C., they got no explosion even when they passed an electric discharge along the tube or caused a piece of cotton to burn in the gas. We find that, in a 3-cm. diameter 'Pyrex' tube at 100° C., thermal decomposition flames and explosions are very readily initiated by a hot wire or a spark when the pressure is about 2 cm. of mercury or higher. At atmospheric pressure the explosion is very violent and is initiated by catalytic spots on imperfectly cleaned glass. The minimum temperature to which a wire must be heated to cause immediate ignition of the gas at atmospheric pressure has been roughly determined to be about 600° C. Thus, hydrogen peroxide seems similar in its behaviour in the vapour phase to the di-alkyl peroxides with which Harris[2] obtained thermal explosions. These compounds, unlike hydrogen peroxide, decompose entirely homogeneously below 170° C., the temperature around which the explosions occur. The results of the latest workers with hydrogen peroxide are not in complete agreement on this point. Giguère[3] reports no slow thermal decomposition at temperatures as high as 420° C.; but Mackenzie and Ritchie[4] are of the opinion that their results may indicate an appreciable gas-phase reaction in the upper part of their temperature range (namely, 82–137° C.).

It has been found possible to stabilize the flame at pressures as low as 4 cm. of mercury on a jet. It is then clearly visible in a darkened room. An interesting effect is produced by igniting the vapour above rapidly boiling liquid. The flame comes to rest on the surface, and the liquid then boils away steadily but much more quickly than before, going straight to the decomposition products. When resting on the liquid, the flame becomes less easily visible, probably because its temperature is lowered by the presence of a fine spray of the liquid.

The vapour explosion shows no tendency to pass to the liquid phase even when that is 99·8 per cent hydrogen peroxide boiling at atmospheric pressure (*c.* 150° C.). It is clear that most of the explosions said to result from heating concentrated hydrogen peroxide solutions to 150° C. occur in the vapour, and not the liquid phase as is generally implied[5].

It is proposed to continue to study this interesting reaction in greater detail, and to publish a full report elsewhere.

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Vibrations of an Infinitely Long Chain of CH_2-Groups and the Infra-red Spectrum of Polythene

THE vibrations of an infinitely long chain of CH_2-groups have been calculated using a valence and angle force potential. It is assumed that the carbon atoms form a zigzag line in the x,y-plane, from which the two C—H linkages branch off symmetrically with respect to this plane, with the x-axis as molecular axis. This array can be considered as a crystal lattice the elementary cell of which consists of two CH_2-groups (six particles in the cell) resulting in eighteen vibrations of the elementary cell. The potential function V has the form:

$$2V = f_C \sum_i l_i^2 + f_H \sum_i (l_i'^2 + l_i''^2) + b^2\varphi_H \sum_i \beta_i^2 +$$
$$a^2\varphi_C \sum_i \lambda_i^2 + ab\,\varphi_{CH}\left\{\sum_i(\delta_i'^2 + \delta_i''^2) + \sum_i(\varepsilon_i'^2 + \varepsilon_i''^2)\right\} +$$
$$2\,ab \sin\frac{\theta}{2}\,\tau \sum_i \Psi_i^2.$$
$$(\lambda_i = \beta_i - \delta_i' - \delta_i'' + \varepsilon_i' + \varepsilon_i''),$$

where l_i is stretching of $C_i—C_{i+1}$ linkages; l_i' and l_i'' are stretching of two C—H linkages attached to C_i; λ_i is change of the angle $C_{i-1}—C_i—C_{i+1}$; β_i is change of the angle $H_i'—C_i—H_i''$; δ_i', δ_i'' are changes of the angle $C_{i-1}—C_i—H_i$; ε_i' and ε_i'' are changes of the angle $H_i—C_i—C_{i+1}$; Ψ_i is angle of twist of C—C linkages produced by a rotation of the two CH_2-groups at the ends of the bond around it; a is the equilibrium distance of the carbon atoms, b of the C—H linkages and θ the tetrahedral angle; f_C, f_H, etc., are the force constants associated with these movements.

The vibrations can be split up into two groups, symmetric and antisymmetric with respect to the x, y-plane. There are five frequency branches in the symmetric group and four branches in the antisymmetric group. The eighteen vibrations (corresponding to the phase differences 0 and π) have been evaluated as functions of the force constants and interatomic distances, and the dipole moments associated with them calculated on the assumption that only the C—H linkages carry a dipole moment. Five frequencies turn out to be zero (improper vibrations), and of the remaining thirteen only five are infra-red active. The inactivity of the other vibrations is due to the inner symmetry of the elementary cell (symmetry group S_2(i)).

An attempt has been made to fit these vibrations to the observed infra-red spectrum of polythene[1] (molecular weight 13,000); the results of the calculations are compared in the accompanying table with Thompson and Torkington's[1] and Fox and Martin's[2] observations.

Infra-red spectrum of C_nH_{2n}

Symmetry class	Frequencies in wave numbers		Relative intensities	
	Calc.	Obs.	Calc.	Obs.
A_g	ν_2 1090 cm.$^{-1}$	1080 cm.$^{-1}$ [1]	0	3·5
	ν_3 2880	2853 [2]	0	0·9
	ν_4 1560	—	0	—
	ν_5 890	890 [1]	0	2·0
	ν_6 1617	1640 [1]	0	1·0
A_u	ν_8 717	725 [1]	100 M_z	100 σ [3,4]
	ν_9 2960	2960 [2]	0·7 M_z	0·6
B_g	ν_{12} 1710	1710 [1]	0	0·9
	ν_{13} 1490	1380 ? [1]	0	16 π [4]
	ν_{14} 2980	—	0	—
B_u	ν_{16} 1307	1310 [1]	10 M_x	0·8
	ν_{17} 2884	2925 [2]	1·7 M_y	0·5
	ν_{18} 1460	1460 [1]	65 M_y	27 σ [3,4]

The observed intensities refer to the absorption coefficient at maximum absorption; the calculated intensities are proportional to $n^2e_H^2$, where n is the number of CH_2-groups in the molecule and e_H the effective charge on the CH-dipole. M_x, M_y and M_z are the non-vanishing components of the dipole moment; the observed polarization is indicated by π and σ. π and σ mean that the intensity of the band is stronger when the incident electric vector is parallel or perpendicular to the molecular axis (x-axis). The inactive bands are, with two exceptions, weakly active, possibly on account of the two CH_3-groups at the ends of the molecule. Besides, any folding of the chain would destroy the $S_2(i)$ symmetry, that is, alter the selection rules. The spectra of cracked polythenes observed by Thompson and Torkington[1] seem to show that the case of molecular weight 7100 ($n \sim 500$) must still be treated as a finite molecule, whereas the periodic structure is fully established for a molecular weight of 13,000 ($n \sim 900$).

It is proposed to extend this treatment to more complicated polymers. A detailed report of the calculations will be published shortly.

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Dec. 3.

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Metallic Oxides as Barrier Treatments for Prevention of Attack by Light on Cellulose

ALTHOUGH the literature contains evidence of sporadic attempts to investigate various types of barrier treatments on cellulose for the prevention of attack by light[1,2,3], no systematic work would appear to have been carried out to date on the subject. The evidence is often conflicting, as in the case of iron compounds[1,3], and in any event the mechanism of protective action of such diverse barriers as have been studied is not clear. In the course of a wider investigation on the elucidation of the mechanism of attack by light on cellulose, which is in progress in this Laboratory, it was considered of immediate practical importance to study on systematic lines the influence of certain metallic oxides deposited on cotton fabric in protecting the latter against actinic attack. While the details of the technique of investigation and the results obtained, particularly on the chemical aspect of protection/deterioration of cellulose, are reserved for a future publication, it is the object of the present note to direct attention to the remarkable effect of manganese (as oxide) in inhibiting actinic deterioration.

The metals investigated were chromium, copper, iron, manganese, tin, titanium and aluminium. Three different concentrations of the metals, approximately 0·05, 0·5 and 1 per cent on the weight of fabric, were studied. Dosootie, a fabric of Indian tentage, was used. The metals were deposited as their oxides on the fabric by a double-bath process involving initial treatment in a soluble salt solution and subsequent decomposition with aqueous solution of alkali. The treated fabrics and untreated control pieces were exposed during hours of sunshine at Kanpur (lat. 26° 26′ N., long. 80° 22′ E.) for a total period of 2,400 hours. Samples were drawn according to a randomized plan initially and at intervals of 400 hours. Bursting-strength determinations were carried out at each sampling.

The results showed that manganese (0·56 and 1·3 per cent) on fabrics retards in a remarkable manner the course of actinic degradation; there is possibly a critical concentration of manganese above which only the protective effect is apparent. Although iron and aluminium in the higher concentrations (0·84 and 0·45 per cent respectively) show some protective effect in the very early stages of exposure, they are not useful. Fabrics containing chromium in the higher concentrations (0·8 per cent) generally follow the pattern of the control in the rate of degradation. Copper, tin and titanium accelerate degradation, the effect being most marked in the case of copper and titanium.

While the result with copper is not surprising, the behaviour of manganese in inhibiting actinic degradation has considerable practical possibilities. Confirmatory experiments on this are in progress.

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Preparation of Ferric Succinate Jellies

It is well known that a neutral solution of succinic acid gives a brownish-red precipitate of ferric succinate with a ferric chloride solution. Handl[1] obtained brownish-red crystals of ferric succinate by treating a ferric chloride solution with a solution of sodium succinate. We have now succeeded in preparing ferric succinate jellies.

The jellies have been obtained by the metathetical reactions between ferric chloride and sodium succinate. A ferric chloride solution containing 17·54 gm. of ferric oxide per litre and a 5 per cent solution of sodium succinate were found to give the best jellies. To 4 c.c. of the ferric chloride solution were added different amounts of the sodium succinate solution. The total volume was kept at 6 c.c. in each case. The mixtures were shaken for about thirty seconds and then allowed to stand in a bath maintained at 25° C. The influence of the varying amounts of sodium succinate on the time of setting of the jellies was recorded.

Amount of sodium succinate (c.c.)	Time of setting (hr.)
2·0	1
1·9	2
1·8	4
1·7	6
1·6	9
1·4	15
1·2	24
1·0	36

These jellies, like the jellies of ferric phosphate and ferric arsenate investigated by Prakash[2], and of thorium borate investigated by Mushran[3], are transparent, firm and perfectly stable. It is, however, interesting to note that whereas the other transparent jellies of ferric salts have been obtained by the dialysis of their sols and subsequent coagulation with suitable electrolytes, ferric succinate is the only jelly of iron so far known which has been obtained in a perfectly transparent state by the metathetical process. These jellies do not exhibit any syneresis and maintain their transparency even when kept for a long time. They set more readily at higher temperatures than at low, but lose their uniformity of texture and become opaque when allowed to set at high temperatures.

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Genetical Differences in Taste Sensitivity to Phenylthiourea and to Anti-thyroid Substances

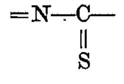
Fox[1] first observed that people differed in their ability to taste phenylthiourea, and it was found (Blakeslee and Salmon[2], Blakeslee[3], Snyder[4,5]) that these differences were genetically determined. The distribution of taste thresholds to this substance in all populations so far studied has been found to be bimodal. Familial investigations indicate that the two classes of individuals, 'tasters' and 'non-tasters', that is, those relatively sensitive and those relatively insensitive to phenylthiourea, differ in respect of a single gene pair, the 'tasters' being homozygous or heterozygous for the dominant allele, the 'non-tasters' homozygous for the recessive allele. Between one quarter and one third of all individuals tested in various populations appear to fall into the recessive class. Fisher, Huxley and Ford[6] have described observations which suggest that similar differences may exist among anthropoid apes. They have pointed out that this implies the existence of a stable, balanced polymorphism, and that, for such a system to occur, the heterozygotes should have had some selective advantage over the two types of homozygotes.

The taste sensitivity to phenylthiourea has been found to show only slight correlation or no correlation at all with taste sensitivity to some other bitter substances, such as quinine[7,8,9], strychnine[7], picric acid[7,9] and diphenylguanidine[10]. On the other hand, Fox[1] observed that 'non-tasters' for phenylthiourea appeared also to be insensitive to several closely related substances, such as *para*-ethoxyphenylthiocarbamide, symmetrical diphenylthiocarbamide, dibenzylthiocarbamide and dicrotylthiocarbamide, whereas 'tasters' for phenylthiourea were sensitive to them. In this work he used only the powder for testing purposes, and did not determine threshold values. He was not able to detect any differences by this method for one closely related substance, thiourea, which he found had a "nauseating taste to both tasters and non-tasters". Riddell and Wybar[11] found that thiouracil tablets were markedly bitter to phenylthiourea tasters and not bitter to phenylthiourea non-tasters. Hopkins[12] found that 2-mercapto-5,5 dimethyloxazoline, a substance which he extracted from the seeds of a cruciferous weed *Conringia orientalis*, was also bitter to phenylthiourea tasters and not bitter to phenylthiourea non-tasters.

8	—	—	—	—	—	—	—	—	1	—	—	4	1	—
7	—	—	—	—	—	—	—	—	—	—	2	1	1	1
6	—	—	—	—	—	—	—	—	2	3	5	—	—	—
5	—	—	—	—	—	—	—	—	1	2	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	1	—	—	—
3	1	2	—	—	2	—	1	—	—	—	—	—	—	—
2	1	—	—	1	1	—	—	—	—	—	—	—	—	—
1	—	1	1	1	—	—	—	—	—	—	—	—	—	—
x	<1	1	2	3	4	5	6	7	8	9	10	11	12	13

Thresholds for phenylthiourea and thiourea for 37 individuals. The abscissa denotes threshold values for phenylthiourea in units of $0{\cdot}26 \times (\frac{1}{2})^x$ per cent. The ordinate denotes threshold values for thiourea in units of $(\frac{1}{2})^y$ per cent. The two groups of 'tasters' and 'non-tasters' are the same for both substances.

Recently, we have developed a method of measuring taste thresholds which aims at determining the lowest concentration of the substance at which an individual can accurately discriminate the solution from water. Using this method, we have tested a number of individuals with phenylthiourea, thiourea, symmetrical diphenylthiourea, thioglyoxaline, thiouracil, phenylurea, uracil and urea. We found that there is a high correlation between taste sensitivity for phenylthiourea, symmetrical diphenylthiourea, thiourea, thioglyoxaline and thiouracil. There was no such correlation between sensitivity to these substances and to urea, phenylurea and uracil. (The accompanying table illustrates the relationship found between sensitivity to phenylthiourea and thiourea.) Thus, substances so far tested, to which the genetically distinct types of individuals respond differently, all contain the grouping


$$=\mathrm{N}-\underset{\underset{\displaystyle \mathrm{S}}{\|}}{\mathrm{C}}-$$

This grouping has been found to be of importance in quite another sphere of biological research.

Chesny, Clawson and Webster[13,14] observed the development of goitre and a decrease in metabolic-rate in rabbits fed exclusively on cabbage. This led to experiments with the *iso*-thiocyanates, important chemical constituents of cabbage, and eventually with thiourea and thiouracil. Thiourea and thiouracil have been found to interfere with the function of the thyroid gland and to reduce the formation of thyroxine. Many closely related substances have been examined and found to possess the same anti-thyroid activity in various degrees. Some of these substances, for example, thiouracil, methylthiouracil, propylthiouracil, are now commonly used in the treatment of thyrotoxicosis. Astwood, Bissell and Hughes[15] investigated two hundred and twenty different substances and found that two types of chemical structure were associated with antithyroid activity. The more active class possessed the thiocarbonamide grouping. Among the substances tested and found to have antithyroid activity was 2-mercapto-5,5 dimethyloxalidine.

Differences in taste sensitivity may reflect metabolic differences between individuals with respect to these substances. Such metabolic differences could presumably affect the biological fitness of the three genotypes, and hence perhaps lead to a balanced polymorphism.

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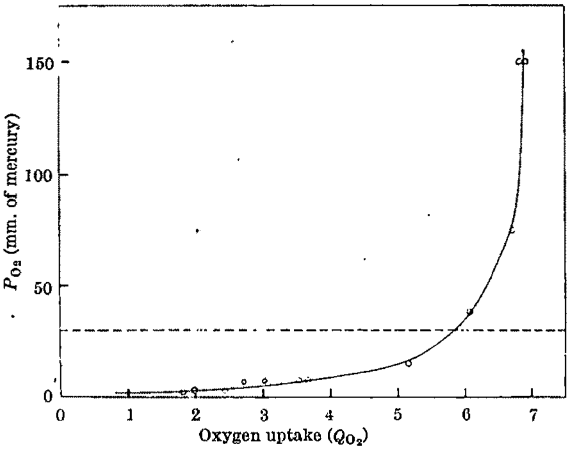
Aerobic Metabolism in Nematode Parasites of the Alimentary Tract

THE conflicting evidence concerning the relative importance of aerobic mechanisms in the metabolism of nematode parasites of the alimentary tract may be summarized by reference to the work of Davey[1], who found that oxygen prolonged the survival of certain intestinal parasites *in vitro*, and that of von Brand and Weise[2], who found oxygen to be absent, or present only in small amounts, in the contents of the alimentary tracts of several host animals.

The problem has been re-examined in the following way: (1) Oxygen tensions in gut fluids close to the mucosa of host animals have been determined in anæsthetized animals with intact alimentary circulations using the electrometric method of Brink and Davies[3]. It was considered that such a method, rather than the analysis of relatively large samples from the intestines of dead animals, would give a more exact indication of the oxygen available to small parasites which probably live close to the mucosa (Porter[4]). (2) The ability of certain nematode parasites of the alimentary tract to utilize oxygen at low partial pressures was next examined. Oxygen uptake was determined by the indirect method of Warburg, using a saline medium in vessels of about 4-ml. capacity. The shaking-rate was adequate, and the oxygen uptake, at a given oxygen tension, was directly proportional to the amount of respiring tissue (50–100 mgm. wet weight).

The parasites examined were *Nippostrongylus muris* from the rat small intestine, *Hæmonchus contortus* from the sheep abomasum and *Nematodirus filicollis* and *N. spathiger* from the sheep small intestine. These parasites were selected because it was thought that they might be small enough to allow oxygen to penetrate to their central tissues even without the aid of a circulatory system, and because they all contain specific hæmoglobins which have low loading tensions, particularly in the case of the sheep parasites (Rogers, unpublished).

Oxygen concentrations close to the mucosa in the small intestine of the rat ('Nembutal' anæsthesia) and in the sheep small intestine and abomasum ('Kemithal' anæsthesia) were determined. Precautions were taken to avoid, as much as possible, the introduction of air into the alimentary tract when electrodes were inserted. In the region of the intestine of the rat where *Nippostrongylus muris* was found, the oxygen tension varied from 19 to 30 (average 24) mm. of mercury in eight animals. Only two sheep were examined; but measurements were taken at four points along the intestine of each animal. Oxygen tensions, as in the rat, were generally higher nearer the pylorus and varied from 12 to 4 (average 6·5) mm. of mercury. The regions normally occupied by the *Nematodirus* spp. showed the lower range of oxygen concentrations. Oxygen tensions on the abomasal mucosa appeared to be higher than in the sheep intestine, but as the technique for handling the abomasum was not satisfactory, these results can only be accepted with reserve.



Oxygen uptake of *Nippostrongylus muris* at different partial pressures of oxygen. The broken line indicates the upper limit of the oxygen concentrations found in the small intestine of the rat host in the region normally inhabited by the parasites

The oxygen consumption of the parasites was found to vary with the oxygen tensions. Results obtained with *Nippostrongylus muris* are shown in the accompanying graph. When the results were treated according to the relationship:

$$A = \frac{P}{K_1 + K_2 P},$$

where A represents the oxygen uptake (ml./hr./gm. dry wt.), P represents the oxygen pressure (mm. of mercury) and K_1 and K_2 are constants, P/A plotted against P gave a straight line with a K_1, the intercept, of 1·2, and a K_2, the slope, of 0·14.

Nematodirus spp. and *Hæmonchus contortus* gave results similar to those obtained with *Nippostrongylus muris*, though both parasites showed less ability to utilize oxygen at low partial pressures. Thus, with oxygen at a pressure of 5 mm. of mercury, *Nippostrongylus muris* showed an oxygen consumption of 40 per cent of the maximum rate, and *Nematodirus* spp. and *Hæmonchus contortus* respired at 25 and 12 per cent of their maximum rates respectively. The results indicate that *in vivo* oxygen tensions may be such that the respiratory-rate may reach 80 per cent of the maximum *in vitro* rate in the case of *Nippostrongylus muris* and 40 per cent in the case of *Nematodirus* spp. *Hæmonchus contortus* probably respires at a relatively lower rate than the intestinal parasites.

It should be emphasized that the above figures are given relative to the maximum rate of oxygen uptake *in vitro*. Even at low oxygen tensions, the parasites make intensely active movements *in vitro* at 37° C.: this activity almost certainly does not occur *in vivo*, in which case the maximum oxygen uptake *in vivo* may be much less than *in vitro*, and respiration *in vivo* may reach a relatively higher rate than the figures given here really indicate.

It may be concluded that aerobic mechanisms play an important part in the metabolism of small nematode parasites of the alimentary tract, particularly in the case of *Nippostrongylus muris* and *Nematodirus* spp.

The results of the work, which was carried out as part of the research programme of the Division of Animal Health and Production, Council for Scientific and Industrial Research, will be published in full elsewhere.

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Lymnæa stagnalis as an Intermediate Host of *Fasciola hepatica*

THE possibility of British species of *Lymnæa*, other than *L. truncatula*, acting as vectors of *Fasciola hepatica* has remained a moot point since Thomas[1], in 1883, observed the miracidia to penetrate young specimens of *L. pereger*. The observation of Nöller and Sprehn[2], in 1924, added to the uncertainty, when by dissection of a young specimen of *L. stagnalis* they actually secured cercariæ that were sufficiently far developed to show the lateral glands. As a result of experiments recently carried out at Weybridge, it can now be stated with certainty that *F. hepatica* is capable of completing its development in *L. stagnalis* with the ultimate emergence of cercariæ, which encyst and are capable of producing fluke infestation in mammals.

The snails used in these experiments were freshly hatched second-generation laboratory-reared specimens, maintained under conditions that would exclude all possibility of unwanted infection, or the ingress of any other species of snail. They were exosed to massive infestation by the miracidia of . *hepatica*, freshly hatched from laboratory incuated eggs, the technique of snail infection being the ame as that employed at the Laboratory for the fection of *L. truncatula*.

Examination of 101 of the experimental snails howed that 13 had become infected. Ten of these 3 were dissected before the developmental cycle of he fluke had been completed, two died soon after ommencing to shed cercariæ; but from the third, 99 erfect cercariæ emerged, including 86 which left the nail within a 24-hr. period, 113 days after the date f infection. Four of these cercariæ were pipetted nto the mouth of a rabbit, and in six weeks time ne half-grown specimen of *F. hepatica* was recovered om the bile ducts.

Attempts to infect adult specimens of *L. stagnalis* ave so far failed, and it is interesting to note that he report of Nöller and Sprehn[2] of partial success ith that species, and the report of Thomas[1] of artial success with *L. pereger*, also referred to young pecimens. It appears, therefore, that immature pecimens are more susceptible than are adults.

Although of biological interest, this observation ay have little significance from the veterinary point f view on account of the definitely aquatic habit f *L. stagnalis*, which appears to be confined to ermanent water. It shows the possibility, however, f the maintenance of liver-fluke infestation in enironments from which *L. truncatula* is absent, and uggests that immature specimens of yet other species f *Lymnœa* may also serve as vectors. The investigaion of these possibilities is proceeding at Weybridge, nd partial development of the fluke in *L. pereger* nd *L. palustris* has already been observed.

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Nöller, W., and Sprehn, K., *Berl. tierargtl. Wscht.*, 40, 369 (192

Symptomatology of Virus Diseases Induced in Cacao by '2–4,D' Treatment

DURING the treatment with commercial '2–4,D' mulsions of small blocks of cacao (*Theobroma cacao*) r weeding, in Venezuela, a peculiar phenomenon as observed incidentally. Basal shoots ('chupons') eact to the treatment with distortion and malformaion, then dropping of young leaves. A few scattered eaves developed from buds were wrinkled, more or ess curled up to rolled, hardened and rugose or mooth, and more or less ruffled. The size of leaves as frequently reduced, chiefly as regards width in elation to the length. A number of leaves were ottled or even chlorotic, but also vein-banded or ith red-stained veins; others were healthy and ormal.

The symptomatology is that of one or two or someimes even more virus diseases, in the same tree, as reviously described in Trinidad by Posnette[1], and n the Dominican Republic and Colombia by Ciferri[2]. f course, the next new flush of foliage consisted of ealthy leaves.

The same effect induced by treatments with 2–4,D' has been observed in Italy on the vine (*Vitis vinifera*) by Baldacci and Topi[3], with symptomatology resembling 'courtnoué' or 'roncet'.

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Nutritional Requirements of *Drosophila*

SINCE our earlier publication[1], the following additional information has been obtained about the nutritional requirements of *Drosophila melanogaster*. Addition of 25 γ thymine per culture to the basal medium leads to accelerated development, pupæ being formed seven days after egg-laying. This represents a decrease in developmental time of one day at least over controls without thymine. Further acceleration can be obtained by addition of 20 mgm. of a yeast fraction prepared by treating yeast with hot 2 per cent sodium bicarbonate, filtering, rendering slightly acid with hydrochloric acid, and precipitating the fraction with an excess of ethanol. Pupation can then ensue five days after oviposition. That the active fraction is not nucleic acid as supplied commercially is shown by the fact that parallel cultures without the fraction, but containing additional nucleic acid, do not show the same effect.

There is also some evidence that the basal medium as constituted at present may be deficient in some specific amino-acid. This is suggested by the fact that the addition of globin (prepared from hæmoglobin by hydrochloric acid hydrolysis and salting out) gave pupæ of much larger size than those obtained from the normal basal medium. This possibility is now being followed up.

For convenience, the composition of the basal medium as now constituted is given below.

	gm.		gamma
Casein (vitamin-free)	0·06	Aneurin hydrochloride	4
Gelatin (reprecipitated)	0·045	Riboflavine	6
dl-Tryptophane	0·005	Nicotinic acid	12
Ergosterol	0·005	Pyridoxin	12
Cholesterol	0·005	Biotin	0·2
Dextrose	0·1	Calcium-*d*-pantothenate	1500
Agar	0·1	Thymine	25
Yeast nucleic acid	0·0034	Inositol	12
Tatum salt mixture (1936)	0·006	Folic acid Choline chloride	2 1000
Water to 5 ml.		(*p*-amino-benzoic acid)	25

Full details will be published elsewhere.

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Pregnancy Test using Male Anura

CONFIRMING the validity of the Galli-Mainini test for pregnancy in the male toad *Bufo arenarum*[1] and referring to the suitability of *B. marinus*[2] and *Rana pipiens*[3], Haines[4] raises the question of the possible suitability of two European species, *B. bufo* and *R. temporaria*. We have demonstrated[5] the suitability of a European frog, *R. esculenta*; and on a theoretical basis we have assumed that the Galli-Mainini test must be common to the Anura (toads and frogs).

Meanwhile, many other species have been successfully employed in America (*B. paracnemis*, *B. crucifer*, *Calyptocephallus gayi*, *Leptodactillus ocellatus*, *Xenopus lævis*, *Odontophrynus*, *B. d'Orbigny*[6], *R. catesbeiana*[7]) and in Europe (*B. vulgaris*, *B. viridis*[8], *B. calamita*[9]).

Fifteen species of toads and frogs having been observed and found suitable, we think that the general hypothesis is largely confirmed. Although it will be practically impossible to establish with certainty that any male toad or frog at any time may be used, there is no special interest in such a theoretical security; for it is always possible to avoid false positive reactions by examination of the animal's urine before the test, and to avoid false negatives by previously testing each animal with urine of a woman known to be pregnant, the tested animal being fit for use after a week. From the latter point of view the testing of one animal from among a uniform batch will usually be sufficient, and the remaining animals can be used immediately.

There is one important difference between different species, namely, the size of the animal. The quantity of urine used should be approximately equal to one tenth of the average weight of the species utilized. No special precautions are necessary as regards the woman's urine; any specimen may be used directly. The activity is conserved at least for a week at room temperature[6]. We have obtained positive results with urine kept for a month in a refrigerator.

There is some doubt on the time convenient for certain results[6]. In a great majority of cases (all in our experience) positive reactions occur within two hours. It can be inferred that in the small percentage of cases of delayed response, the delay would not be greater than a further hour. As a positive reaction at two hours can never become negative at three, we propose to adopt a standard time of about three hours.

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University Education in Natural Science

In the leading article in *Nature* of April 30, attention is rightly directed to the high degree of specialization which is now demanded of our science graduates, a degree of specialization which, as is said there, "too often begins", and as I should say because of university scholarship demands, "usually begins", at school.

A re-organisation of university teaching is clearly long overdue, but it is doubtful whether it will be as difficult as that article suggests. Is not the obvious solution that which I put forward at the meeting of the British Association at Brighton last year, namely, that the first science degree for undergraduates should normally be a general science degree ? I say "normally" because there is no reaso why the special honours degree should not be retaine for exceptional cases. But for the ordinary scientifi student, surely a degree in a number of interrelate subjects is what is required. "It gives a student grounding in a variety of subjects and, if it is properl taught, of necessity it shows the interrelationships those subjects, and it does not lead to that completely unintellectual isolation which results so ofte from the special honours degree."

Many people, of course erroneously, consider general degree as something new and somethin inferior ; but it is not. The first part of the Cambridg Natural Sciences Tripos is a general honours degre and it is certainly neither new nor inferior. This the principle on which I have acted for years Manchester. Students who wish to specialize i zoology are normally advised to take a general scienc course. If they then obtain a first-class or a goo second-class, clearly they are fitted for further stud and can be advised to specialize in a postgraduat year. For such an extension of their studies mone is nowadays forthcoming; but it is only reasonab that such an extra year's work should carry with a further degree, and why not a master's degree In Manchester, for such a degree there is no nee for the work to be original research. It can alternatively consist "of an essay on some scientific questio of importance involving criticism or historic research". It is an easy matter for a head of department to interpret this latter alternative so to include whatever degree of specialization he considers necessary at such a level.

H. Graham Cannon

Department of Zoology,
University,
Manchester 13.

Another Little-known History of Botany

In *Nature* of May 7, p. 732, Dr. Jules Brun inquires about the "L. G." who was responsible f the "Précis de l'Histoire de la Botanique", the las of the seventeen volumes of "Le Règne Végétal" by O. Réveil, and others, Paris, 1870–71. The wor in question is not accessible to me ; but I find tha in the catalogue of the Library of the British Museu (Natural History), "L. G." is identified as "L. Gérard' I do not know on what evidence this is based ; have been unable to trace any botanist of this nam who might be the writer of the "Précis". Lou Gérard is too early in date, as he was born in 173 Dr. Brunel's tentative identification with L. Guéri is perhaps more probable ; but it can hold only the work is considered to be within the compass of man who does not seem to have been a botanist This is possible, as the "Précis" describes itself a "Biographique et Bibliographique". As anothe alternative—though a speculative one—I should lik to suggest Lazare Garreau, who was professor a Lille. He was born at Autun in 1812, and publishe papers on physiological botany in the decade 1850–6 He was apparently still living when the second editio of Pritzel's "Thesaurus literaturæ botanicæ" appeared (1872).

Agnes Arber

52 Huntingdon Road,
Cambridge.
May 18.

EFFECT OF LIGHT ON THE COMBUSTION OF HYDROCARBONS

By Prof. R. G. W. NORRISH, F.R.S., and D. PATNAIK
Department of Physical Chemistry, University of Cambridge

THE slow combustion of hydrocarbons in general takes place by a kinetic process which Semenov[1] described as a chain reaction showing 'degenerate ranching'. According to this conception, the hydrocarbon is first oxidized to a moderately stable intermediate, which is itself oxidized to the final products, amely, carbon monoxide, water, etc. Thus a stationary concentration of the intermediate is built up during the reaction, which reaches a maximum t the time of maximum velocity. According to Semenov's conception, the intermediate is responsible for the starting of new chains by an alternative eaction with oxygen, and a delayed or degenerate branching results.

In the case of methane[4] and ethylene, the intermediate may be identified with formaldehyde, which, as shown by Bone, Haffner and Rance[2] and by Harding and Norrish[3], reaches a maximum concentration at the point of maximum velocity, and which when added to the reactants in the right amount c. 1·0 per cent) completely removes the induction period[4].

The complete scheme derived for the oxidation of methane[6], based on the work of Norrish and Foord on methane[4] and Axford and Norrish[5] on the oxidation of formaldehyde, is as follows:

$$\left.\begin{array}{lll} k_1 & CH_4+O_2 & = CH_2O+H_2O \\ k_2 & H_2CO+O_2 & = H_2CO_2+O \\ k_3 & O+CH_4 & = CH_3+OH \end{array}\right\}\text{Initiation and degenerate branching}$$

$$\left.\begin{array}{lll} k_4 & OH+CH_4 & = CH_3+H_2O \\ k_5 & CH_3+O_2 & = H_2CO+OH \end{array}\right\}\text{Propagation}$$

$$\left.\begin{array}{lll} k_6 & CH_2O+OH & = CO+H_2O+H \\ k_7 & H+O_2+H_2CO & = CO+H_2O+OH \end{array}\right\}\text{Coupled formaldehyde chain*}$$

$$\left.\begin{array}{lll} k_8 & H+O_2+X & =HO_2+X' \\ k_9 & OH+\text{surface} & \rightarrow \text{termination} \end{array}\right\}\text{Termination*}$$

* Reactions (7) and (8) are only formally to be regarded as ternary reactions. The transition complex HO_2 formed with c. 50 k.cal. is unstable unless deactivated (reaction (8)), and reactive only if it encounters a formaldehyde molecule (reaction (7)) before it decomposes, or is deactivated.

In this mechanism, the concentration of formaldehyde, initially zero, grows very slowly at first, during the induction period; and later, as the delayed branching by reaction (2) takes effect, at an ever-increasing rate. But the rate of the oxidation of formaldehyde by reactions (6) and (7), which as is generally agreed depends approximately on the square of its concentration, grows still faster, so that eventually a stationary concentration is reached when its rate of destruction is equal to its rate of production. At this point the velocity of reaction must cease to increase; it settles down to a steady value which finally falls off as the reactants are consumed. Thus we get the familiar S-shaped pressure–time curves. A similar scheme has been derived for the oxidation of ethylene[6].

The steady rate is readily shown to be given by the kinetic equation[6]

$$\frac{-d(\text{Hy})}{dt} = \frac{k_4}{k_6}\left(k_3(\text{Hy})(O_2) + \frac{k_2k_4k_7(\text{Hy})^2(O_2)Pd}{2k_7k_9\sigma + 2k_6k_8P^2d}\right), \quad (1)$$

where (Hy) stands for methane or ethylene, σ the specific surface activity per square cm. for termination by reaction (9), P the total pressure in the system and d the diameter of the reaction vessel. The first term on the right-hand side represents the initiation process, the second the propagation; and the former is generally negligible in comparison with the latter. With methane, the first term in the denominator is large compared with the second, which can be neglected; with ethylene, which oxidizes at a lower temperature, the two terms are of comparable magnitude. This circumstance is responsible for minor differences in their oxidation kinetics.

This general view of the oxidation of methane and ethylene led us to the conclusion that the combustion reaction should be accelerated by light, which is known to dissociate formaldehyde into free radicals, for the degenerate branching reaction (2) would now be augmented by the photochemical process

$$\begin{array}{l} H_2CO + h\nu = H + HCO \\ \qquad\qquad\qquad\qquad\quad \searrow \\ \qquad\qquad\qquad\qquad\quad H + CO \end{array}$$

as a chain-starting mechanism.

If the rate of absorption of light by formaldehyde is given by $k(H_2CO)I$, where I is the incident intensity, the rate equation now becomes modified to

$$\frac{-d\text{Hy}}{dt} = \frac{k_4}{k_6}\left(k_3(\text{Hy})(O_2) + k(\text{Hy})I + \frac{k_2k_4k_7(\text{Hy})^2(O_2)Pd + kk_4k_7(\text{Hy})^2IPd}{2k_7k_9\sigma + 2k_6k_8P^2d}\right). \quad (2)$$

Subtracting the rate in the dark (R_D) from the rate in the light (R_L) we obtain:

$$R_L - R_D = \frac{k_4}{k_6}\left(k(\text{Hy})I + \frac{kk_4k_7(\text{Hy})^2IPd}{2k_7k_9\sigma + 2k_6k_8P^2d}\right); \quad (3)$$

or, keeping σ, I and d constant:

$$R_L - R_D = (\text{Hy}) + \frac{a(\text{Hy})^2P}{b + cP^2}. \quad (4)$$

If, in addition, the total pressure P be kept constant by making up with nitrogen,

$$R_L - R_D = (\text{Hy}) + K(\text{Hy})^2. \quad (5)$$

These predictions have all been confirmed. We used a cylindrical quartz reaction vessel (diameter 3·4 cm., volume 175 c.c.) in a horizontal electric furnace lined with polished aluminium with a quartz window 7 cm. in diameter at one end. A beam of light of high intensity obtained from a high-pressure point-source mercury arc, burning 1 kW., and 'cooled' by passing through 50 cm. of water contained in a tank with parallel quartz sides, was focused into the furnace by means of a searchlight mirror of polished aluminium. The reaction was followed by pressure change, measured by a glass spoon gauge sensitive to a pressure of 0·05 mm. mercury. Fig. 1 shows a typical result.

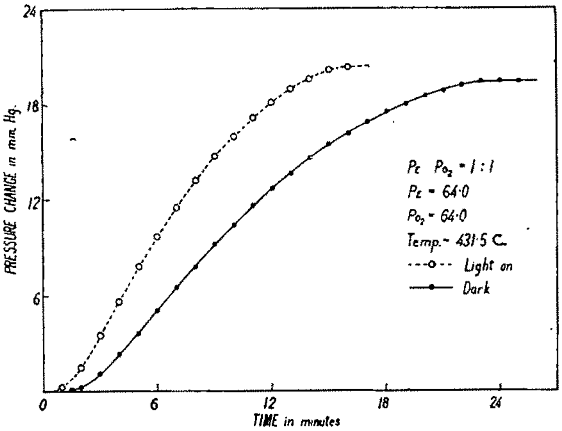

Fig. 1. Effect of light on the slow oxidation of ethylene

When the light beam was passed through a colour filter of 0·5 per cent solution of quinine hydrochloride 7 cm. thick, which cuts out all light of wave-length shorter than 3600 A., the acceleration due to the light was very nearly (90 per cent) suppressed. The formaldehyde absorption spectrum extends from 3750 A. to beyond 2500 A., whereas the spectrum of the lamp extended to 2450 A.; thus the active light lies in the ultra-violet in the region covering the absorption band of formaldehyde. With a more concentrated solution of quinine hydrochloride (2·5 per cent) cutting out all light of less than 4000 A., the effect was completely suppressed.

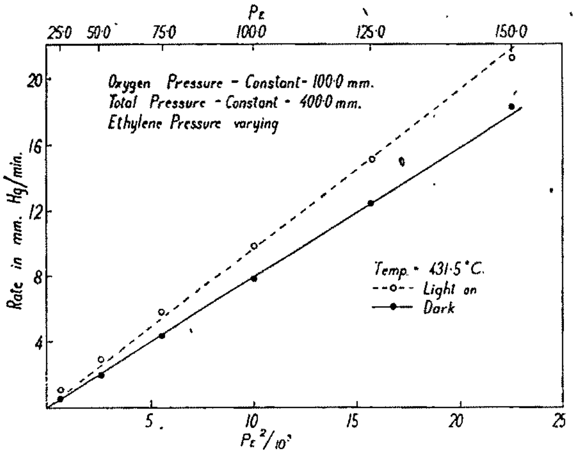

Fig. 2. Effect of light on the slow oxidation of ethylene; ethylene varying, total pressure constant

Figs. 2–5 show that R_L and R_D conform to equations (1) and (2), and that $R_L - R_D$ is independent of (O_2) and approximately proportional to $(Hy)^2$, as is required by equation (4) if the terms in Hy (initiation) are small compared with the terms in Hy^2 (propagation), and if b is large compared to cP^2, as it is in the case of methane. With ethylene we kept the total pressure P constant by adding nitrogen, and therefore $R_L - R_D$ is given by equation (5). Under these conditions, when (Hy) is small the first term in equation (5) preponderates, and $(R_L - R_D)$ is more nearly proportional to (Hy) than $(Hy)^2$. The fact that the experimental points for low (Hy) in Fig. 2 lie above the line is in accord with this.

By working close to the ignition limit with ethylene (C_2H_4 = 225 mm., O_2 = 318, temp. 431° C.) we were readily able to convert a 'slow' dark reaction into an ignition by irradiation; but in this region equation (1) is no longer obeyed owing to the large measure of self-heating as the ignition limit is approached.

These results accord well with the reaction scheme based on formaldehyde outlined above, and confirm the kinetic formulæ previously deduced. They show in effect, that the degenerate branching process can be powerfully affected by light without altering the character of the reaction; and the effect is all the more striking when it is remembered that the initial reactants are completely transparent to the light used.

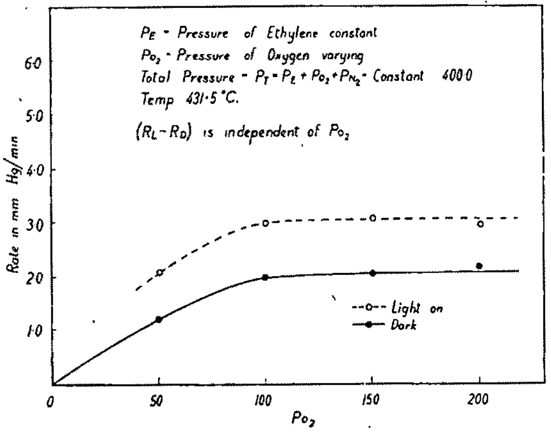

Fig. 3. Effect of light on the slow oxidation of ethylene; oxygen varying, total pressure constant

By using the weaker colour filter (0·5 per cent quinine hydrochloride) it was shown that the effect still persists feebly in light the spectrum of which lies between 3600 A. and 4000 A. Now the predissociation limit of formaldehyde as shown by the threshold of fluorescence is at c. 3000 A.[7], and it must therefore be concluded that some such reactions as

$$H_2CO + h\nu = H_2CO'$$
$$H_2CO' + O_2 = H_2CO_2 + O$$

take place in this region; that is, that reaction (2) is somewhat enhanced by light which excites, but does not split, the formaldehyde molecule.

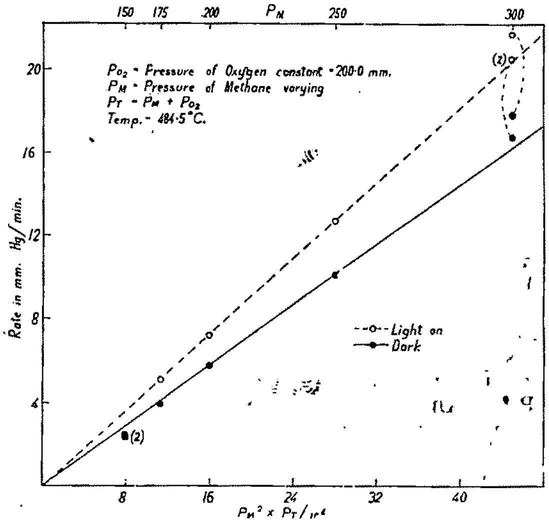

Fig. 4. Effect of light on the slow oxidation of methane; methane varying

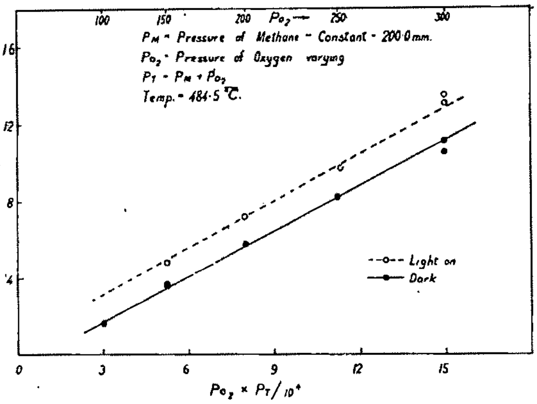

Fig. 5. Effect of light on the slow oxidation of methane; oxygen varying

With heavier hydrocarbons the characteristics of egenerate branching are similarly observed, and we elieve that the heavier aldehydes which are first roduced are similarly responsible for the delayed ranching reaction. On this basis it is possible to uild a self-consistent mechanism of a pattern esembling the simpler reactions treated here[6]. It is gnificant that light readily accelerates the oxidation f butane, and the shapes of the curves in the dark nd in the light suggest different end points; it is robable that the phenomenon will be found to be eneral for hydrocarbons.

This photochemical effect provides a new experiental approach to the study of the reaction kinetics f combustion, and cannot fail to be revealing.

Semenov, *Z. phys. Chem.*, 11B, 464 (1930); *Phys. Z. d. Sowjetunion*, 1, 546 (1932); "Chemical Kinetics and Chain Reactions", 68 (Oxford, 1935).

Bone, Haffner and Rance, *Proc. Roy. Soc.*, A, **143**, 16 (1933).

Harding and Norrish, *Nature*, **163**, 797 (1949).

Norrish and Foord, *Proc. Roy. Soc.*, A, **157**, 503 (1936).

Axford and Norrish, *Proc. Roy. Soc.*, A, **192**, 518 (1948).

Norrish, communication to the Centre National de la Recherche Scientifique, Paris, 1948 (in course of publication).

Herzberg and Franz, *Z. Phys.*, **76**, 720 (1932). Gradstein, *Z. phys. Chem.*, B, **22**, 384 (1933).

OPTICAL PROPERTIES OF SOLID THIN FILMS

A MOST successful international colloquium on the optical properties of solid thin films was held at Marseille during the week April 19–23 under the auspices of the Centre National de la Recherche Scientifique. Some forty-four physicists attended by nvitation, and, of these, twenty-five contributed papers. There was, of course, a strong contingent from France, including, among others, P. Jacquinot, M. Perrot and P. Rouard. From Great Britain contributions were read by K. M. Greenland, O. S. Heavens, H. Kuhn and S. Tolansky. The United States were represented by B. H. Billings, N. W. Scott, J. Strong and A. F. Turner, the Netherlands by P. van Alphen and B. Blaisse, Italy by M. Ballerini, Switzerland by M. Schaetti and Czechoslovakia by A. Vasicek.

The conference was well organised by Prof. P. Rouard, director of the physical laboratory in the University of Marseille, and was characterized by smooth, efficient working and excellent programme planning. This meeting was held in a provincial university as part of deliberate policy of the Centre National de la Recherche Scientifique, which is arranging a series of international conferences in French provincial university centres. The choice of Marseille for this particular subject of optical properties of thin films was a happy one indeed; for it was there, at the beginning of this century, that Fabry laid the foundation of the very subject under discussion, and it was there, too, under his inspiration that the branch of classical optics associated with the names of Fabry, Buisson, Macé de Lepinay and others was created. Indeed, the visitors all derived considerable pleasure from an exhibition of the original apparatus used by these masters of experimental optics, and were much moved, too, by listening to a recording of the voice of Fabry.

Although a considerable number of papers were read (many contributors read several: for example, the writer contributed five), these all crystallized into four fairly distinct groups: (*a*) determination of optical properties and thickness of thin metal or dielectric films; (*b*) the principles and applications of multiple-beam interferometry; (*c*) preparation of interferometric wave-length filters and discussion of their characteristics; (*d*) improving the optical properties of surfaces by deposition of multiple films with alternate low and high refractive indices.

The conference opened with a session of theoretical papers on the properties of single and multiple thin films, and then plunged into its main work, which consisted of formal papers on experimental aspects connected with the properties and optics of thin films. Occasionally the conference assumed the character of informal discussions on experimental techniques, yet all were agreed that these informal exchanges constituted one of the most valuable features of the whole conference. For it is a fact that success with experimental interferometry, or with those other branches of applied optics which involve surface deposition of films, depends largely upon minor details of personal techniques which are not easily publishable, and are, indeed, often even difficult to describe. For example, a most lively discussion ensued simply on the question of the best method of cleaning a glass surface which is to accept a film by deposition by vacuum evaporation. There were perhaps ten speakers, with the inevitable result that perhaps ten distinctly different techniques were described; but all had one thing in common, namely, final cleaning by ions with a gas discharge. It appears that any reasonable method of cleaning is satisfactory provided the glow discharge is the final cleansing agent.

Many striking and novel optical results were described, and it is anticipated that all the papers contributed will be published together in some form. Such a collection will make a notable contribution to a subject rapidly becoming of considerable importance to technical optics, particularly those fields concerned with either reduction or enhancement of reflectivities of surfaces. The conference was an unqualified scientific success and equally successful socially, thanks largely to Prof. Rouard. The visitors will long remember the magnificent hospitality of their French colleagues. A visit was paid to the astronomical observatory at St. Michel, the visit being of mutual benefit to visitors and residents, for the astronomers there were glad to welcome so much expert opinion on the problems associated with the coating of the mirrors of their reflector telescopes.

On the break-up of the conference everyone felt that he was carrying away many new techniques, little tricks of the trade and valuable 'know-hows', for there was a very frank exchange of knowledge, even from those who represented large commercial organisations, and who might have been forgiven for hesitating to release trade secrets. There were, in fact, no such hesitations, either from the commercial or government representatives who attended, and, indeed, the liaison between the industrial and academic research workers was all that could be desired.

S. TOLANSKY

PHYSICAL SOCIETY

ANNUAL MEETING

AT the annual general meeting of the Physical Society, held at the Royal Institution on May 6, the reports of the Council and Treasurer and the accounts and balance sheet for 1948 were presented and adopted, and the officers and Council for 1949–50 were elected as follows: *President*, Prof. S. Chapman; *Vice-Presidents* who have filled the office of president, Prof. C. H. Lees, Sir Frank Smith, Sir Owen Richardson, Dr. W. H. Eccles, Prof. A. O. Rankine, Mr. T. Smith, Dr. Allan Ferguson, Sir Charles Darwin, Prof. E. N. da C. Andrade, Prof. D. Brunt, Prof. G. I. Finch; *Vice-Presidents*, Dr. W. D. Wright, Dr. W. Jevons, Mr. C. H. Collie, Prof. R. Peierls; *Honorary Secretaries*, Mr. C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Dr. H. Shaw; *Honorary Librarian*, Dr. R. W. B. Pearse; *Members of Council*, Dr. D. Roaf, Dr. A. C. G. Menzies, Dr. F. C. Toy, Mr. J. H. Awbery, Prof. L. F. Bates, Dr. R. C. Evans, Prof. L. C. Martin, Dr. C. E. Wynn-Williams, Dr. A. G. Quarrell, Dr. A. B. Wood, Prof. Willis Jackson, Prof. H. S. W. Massey.

The officers for 1949–50 of the four Groups of the Society are as follows: *Colour Group:* Chairman, Dr. W. S. Stiles; Honorary Secretary, Mr. R. G. Horner. *Optical Group:* Chairman, Prof. L. C. Martin; Honorary Secretary, Mr. G. S. Speak. *Low Temperature Group:* Chairman, Prof. F. E. Simon; Honorary Secretary, Dr. G. G. Haselden. *Acoustics Group:* Chairman, Mr. H. L. Kirke; Honorary Secretaries, Mr. W. H. Allen and Mr. A. T. Pickles.

During 1948, which the Council report states was a satisfactory year for the Society, there was a net increase in the membership of some six per cent, making the total at the end of the year only a few short of two thousand. Despite the increase in the fellows' annual subscription from two to three guineas, there were very few resignations and lapses. The financial position, though somewhat improved, still gives cause for anxiety.

In addition to the ordinary science meetings, a two-day summer meeting devoted to microwave spectroscopy was held at the Clarendon Laboratory, Oxford, and a full-day meeting at the Research Department of Metropolitan-Vickers Electrical Co., Ltd., Manchester, on surface structure and electrical properties of semiconductors. Prof. E. O. Lawrence was elected an honorary fellow in May, and Prof. R. W. Wood, one of the honorary fellows of the Society, lectured at one of the science meetings on the spontaneous deformation of crystals. The thirty-second Guthrie Lecture was delivered by Sir George Thomson, who spoke on the growth of crystals, and Profs. S. Tolansky and Y. Rocard were the recipients of the fourth (1948) Charles Vernon Boys Prize, and the third (1948) Holweck Prize of the Physica Society and Holweck Medal of the Société Française de Physique, respectively.

The thirty-second exhibition of scientific instruments and apparatus, held in April, had an attendance of about 9,400 visitors, and was again a great success The four subject-Groups of the Society, the Colour, Optical, Low Temperature, and Acoustics Groups, have all been active during the year, and brief details of their composition and meetings are listed in the annual report.

In addition to the *Proceedings*, the publications of the Society during the year included: vol. 11 (1946–47) of *Reports on Progress in Physics*; and special reports such as the "Report on Colour Terminology", the "Strength of Solids", a report of the 1947 Bristol Conference, and "Emission Spectra of the Night Sky and Auroræ". In order to cope with the increased number of papers suitable for publication in the *Proceedings*, and to expedite publication, it was decided that from January 1949 the *Proceedings* should appear monthly in two sections, section *A* covering atomic and sub-atomic physics, including such subjects as crystal structure, quantum mechanics and spectra, and section *B* macroscopic physics, including such subjects as acoustics, optical design and radio. A new feature, introduced in 1948 and now appearing regularly in the *Proceedings*, is "Letters to the Editor", a section similar to that of the same name appearing in *Nature*.

It is to be hoped that the sales of the special reports will improve, so that the decision of the Council to curtail the production of these reports will be rescinded.

S. WEINTROUB

THE SMITHSONIAN INSTITUTION

REPORT FOR 1947–48

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1948*, again emphasizes the handicap placed on the work of the Institution by shortage of staff and of adequate buildings. Additions to the collections of the National Museum during the year numbered 507,000, and field parties from the Museum visited Arnhem Land in Australia, the antarctic continent, the Bikini area in the Pacific, the Persian Gulf, Colombia, Panama, and other parts of the world. The Department of Biology has been divided into those of Zoology and Botany, and the Division of Aeronautics has become the nucleus of the National Air Museum.

The director of the Bureau of American Ethnology conducted archæological excavations in western Panama in co-operation with the National Geographic Society, discovering a new, very early culture, while the associate director of the Bureau was occupied mainly with the river basin surveys. Surveys made in eighteen States and thirty-eight reservoir areas have led to 250 sites being recommended for excavation to recover archæological material which might be lost through the construction of dams and river valley reservoirs. An autonomous unit of the

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* Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1948. (Publication 3952.) Pp. ix+158. (Washington, D.C.: Government Printing Office, 1948.) 55 cents.

Bureau, the Institute of Social Anthropology, gave courses in anthropology and conducted co-operative field work in Brazil, Columbia, Mexico and Peru.

The International Exchange Service made the first shipments of exchange publications to Japan since the War, and now sends consignments to all countries except Roumania. In return for similar material received from other countries, ninety-four sets of United States official publications, seventy-three copies of the Federal Register, and sixty-six copies of the Congressional Record were sent abroad. Visitors to the National Zoological Park increased by more than 300,000, and the collection at the close of the year totalled 2,797 animals representing 690 different species. The Astrophysical Observatory terminated the sun and sky radiation studies at Camp Lee, but similar studies will continue at the Montezuma and Miami stations. Promising sites for a new high-altitude station were located in Mexico, southern California, and the Hawaiian Islands. The Division of Radiation and Organism substantially completed its studies of the respiration of broad-leaf plants, the effects of environmental factors on the germination of lettuce seeds, and the developmental physiology of grass seedlings.

A total of 165,740 copies of Smithsonian publications was distributed during the year, and a complete list of the publications during the year is appended. The Library received 53,129 publications, and 36,701 pieces from its collection of duplicates were selected for destroyed libraries overseas. About half the 915,987 volumes of the Library are housed as the Smithsonian Deposit in the Library of Congress. The financial report of the executive committee of the Board of Regents and the usual departmental reports are appended.

LICHENS OF ANTARCTICA

IN a vegetation devoid of vascular plants, as the antarctic continent is generally believed to be, the lichens assume a quite unusual importance. The meticulous study of the lichens of Antarctica and the subantarctic islands recently published (B.A.N.Z., Antarctic Research Expedition Report. Vol. 7, Lichens and Lichen Parasites, by C. W. Dodge. Adelaide, 1948) is therefore a very significant contribution to knowledge of these remote and inhospitable regions, incomplete as it must necessarily be.

The material was collected by several different expeditions, the Australian Antarctic Expedition of 1911–14, the British, Australian, New Zealand Expedition of 1929–31, and there is some residual material from the British Antarctic Expedition of 1907–9. Unfortunately, a large part of the collections from the subantarctic islands of the Indian Ocean visited by the 1929–31 expedition was lost during the bombing of London, having accidentally been sent to the British Museum; but it is indeed fortunate that the bulk of the collections had been sent to the Herbarium of the Missouri Botanic Garden, in which the most complete set has been retained, and that Dr. Dodge was free to devote the very considerable amount of skilled attention to them that this publication obviously shows.

It is not profitable to summarize the purely taxonomic side of the work which will only concern the specialist, but no plant geographer can afford to ignore the implications of geographical distribution outlined in the introduction. Three totally distinct floras are discerned, that of Antarctica itself, which is still very imperfectly known, that of Macquarie Island, which seems wholly unrelated to it though with some affinities with both New Zealand and Tasmania, and thirdly "Kerguelia", which is the name used to cover Kerguelen Island, Heard Island, the Crozets and Prince Edward Island groups.

The lichen flora of Kerguelia is remarkable for the very high proportion of endemism in it, possibly all, and certainly 118 out of the total of 124 known species, being in this category. This can only mean very prolonged isolation. The generic affinities, many of which are also endemics, are, however, of even greater interest since they seem to imply remote physical connexions of some kind over immense distances in the most diverse directions, which include Fuegia, the Auckland Islands, South Africa and the Andes. Evidence of this kind, though insufficient in itself to establish major hypotheses such as that of continental drift, is nevertheless closely cognate to any discussion of such problems. This is perhaps the most important aspect of the study of lichen distribution in the southern hemisphere, since lichens, more perhaps than any other form of plant life, have special limitations in their mode of distribution over long distances. It is therefore greatly to be hoped that further contributions will in due course be made to this very promising, though hitherto much neglected and difficult, field of inquiry.

FORTHCOMING EVENTS

Tuesday, June 7

British Society for the History of Science (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. A. C. Crombie: "Theory and Experiment in the Science of Robert Grosseteste"; Mr. H. C. King: "The Optical Work of Charles Tulley".

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Åke Campbell: "The Colonization of Lappland and Culture Contacts between Farmers and Nomads".

Wednesday, June 8

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Combustion of Hydrocarbons".

Thursday, June 9

Royal Statistical Society, Research Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Symposium on "Stochastic Processes".

Research Defence Society (at Manson House, Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting; Prof. C. Lovatt Evans, F.R.S.: "Physiological Research and the Vivisection Act" (Eighteenth Stephen Paget Memorial Lecture).

Friday, June 10

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. T. Smith, F.R.S.: "The Contributions of Thomas Young to Geometrical Optics, and their Application to Present-day Questions" (Thomas Young Oration). (Members of the Optical Group are invited.)

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. S. W. Wooldridge: "The Structure and Morphology of the Country around Fernhurst, Sussex".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (June 11).

Lecturers in Biological Subjects (Botany and Zoology)—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (June 11).

Assistant Lecturer in the Department of Philosophy—The Registrar, The University, Liverpool (June 11).

Readership in Applied Physiology at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 13).

Lecturer in Engineering—The Registrar, King's College, Newcastle-upon-Tyne (June 15).

Director of the Commonwealth Bureau of Dairy Science, Shinfield, Reading—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (June 15).

Senior Lecturer (Grade I) in Horticultural Science—The Secretary and Registrar, The University, Bristol (June 20).

Lecturer or an Assistant Lecturer in Mechanical Engineering, and an Assistant Lecturer in Mathematics—The Registrar, College of Technology, Manchester 1 (June 20).

British Coke Research Association Fellowship—The Registrar, King's College, Newcastle-upon-Tyne (June 21).

Gas Light and Coke Company Research Fellowship in Gaseous Fuel and Combustion—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 24).

Lecturer in Electrical Engineering—The Registrar, The University, Leeds 2 (June 25).

Research Officer in the Wool Textile Research Section (Ref. No. 2031), at Geelong, and a Research Officer in the Division of Industrial Chemistry (Ref. No. 2159), at Fishermen's Bend, Melbourne, of the Australian Council for Scientific and Industrial Research—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (June 25).

Assistant Lecturer in Botany, and Assistant Lecturers (2) in Zoology—The Registrar, The University, Reading (June 27).

Agricultural Economist in the Department of Agriculture—The Registrar, The University, Leeds 2 (June 27).

Lecturer in Bacteriology—The Secretary, The University, Birmingham 3 (June 30).

Experimental Officers (2, one for work on cereal breeding, and the other for work on potato breeding), a Scientific Officer for work on genetical and cytological problems, and a Senior Scientific Officer to work on genecological problems of the herbage plant section dealing with the distribution of intra-specific variation in wild and cultivated plants—The Secretary, Scottish Society for Research in Plant Breeding, 8 Eglinton Crescent, Edinburgh 12 (June 30).

Senior Lecturer in Engineering Physics, Senior Lecturers (2) in Electrical Engineering, and a Lecturer in Electrical Engineering, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2576 (June 30).

Curator of the Department of Natural History in the Museum, Kelvingrove, Glasgow—The Town Clerk, City Chambers, Glasgow, C.2, endorsed 'Curator of the Department of Natural History' (June 30).

Senior Lecturers in Veterinary Pathology, in Veterinary Anatomy, and in Veterinary Physiology—The Secretary and Registrar, The University, Bristol (June 30).

Research Officers (3) to work on sugar beet breeding, leguminous forage crop breeding, and cytogenetic investigations—The Secretary, School of Agriculture, Cambridge (June 30).

University Lecturer in Theoretical Electrodynamics and Radio—Dr. F. B. Kipping, Chemical Laboratory, Cambridge (July 1).

Experimental Officer for supervision of metallurgical laboratory, and an Assistant Experimental Officer for interpretation of analyses primarily with casting, hot and cold working of non-ferrous alloys, in a Ministry of Supply factory in Co. Durham—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.366/49A (July 6).

Inspector under the Dangerous Drugs Acts, in the Home Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2596 (July 7).

Readership in Anatomy at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 7).

Lecturer in Forestry—The Secretary, The University, Aberdeen (July 21)

Senior Lecturer in Mathematics (Statistics) at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 30).

Research Chemist for work on the development of new methods of chemical analysis—The Director, British Cast Iron Research Association, Alvechurch, Birmingham.

Entomologist (male) for service with a research unit undertaking a large-scale mosquito eradication experiment in Mauritius using D.D.T. and B.H.C. insecticides—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer (Grade II) in Organic Chemistry, an Assistant Lecturer in Physical Chemistry, a Demonstrator in Physical Chemistry, and a Demonstrator in Organic Chemistry—The Registrar, The University, Nottingham.

Senior Technician and a Technician in the Department of Pathology—The Superintendent, Royal Infirmary, Infirmary Road, Sheffield 6.

Lecturer in the Department of Chemistry and Metallurgy, and a Lecturer in the Department of Physics and Electrical Engineering—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10.

Agricultural Chemists in the Colonial Service in East Africa, West Africa and the Federation of Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Technician (Grade IV) in the Department of Physics—The Secretary, University College, Gower Street, London, W.C.1, quoting Physics/3.

Senior Assistant for the teaching of Organic Chemistry up to Final Special B.Sc. standard, and a Lecturer in Mathematics to B.Sc. Engineering and B.Sc. General Degree—The Principal, Medway Technical College, Gillingham.

Assistant Experimental Officers (covering a wide variety scientific, including engineering, qualifications) in various Governm Departments—The Secretary, Civil Service Commission, Scient Branch, 27 Grosvenor Square, London, W.1, quoting No. 2522.

Veterinary Research Officer in the East African Tsetse a Trypanosomiasis Research and Reclamation Organisation, for wo in connexion with the trypanocidal drug 'Antrycide', and a Veteri ary Research Officer (Animal Husbandry) in the East Afric Veterinary Research Organisation—The Under-Secretary of Sta Colonial Office, Research Department, Sanctuary Buildings, Gre Smith Street, London, S.W.1.

Senior Lecturer in Building Science at the Leeds College Art (School of Architecture)—The Director of Education, Educati Offices, Leeds 1.

University Lecturers (2) in Mathematics (with special qualific tions either in Algebra or in Quantum Theory), and Universi Assistant Lecturers (2) in Mathematics—Dr. A. J. Ward, E manuel College, Cambridge.

Superintending Pharmaceutical Chemist for the Medical D partment, Government of Federation of Malaya—The Crown Age for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 18288/3

Laboratory Technician (Grade III) in the Department Pharmacology—The Secretary, University College, Gower Stre London, W.C.1, quoting Pharmacology/2.

Chief Chemist for the Process Control Laboratory, East Afric Industrial Management Board, Nairobi, Kenya—The Crown Agen for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21789/3E.

Electrical Engineers for the Electricity Department of t Federation of Malaya—The Director of Recruitment, Colonial Offic Sanctuary Buildings, Great Smith Street, London, S.W.1, quoti No. 27326/18.

Technician for Hæmatological Department—The Direct Ashford Hospital, Ashford, Middx.

Cerealist for the Directorate-General of Agriculture, Governme of Iraq—The Crown Agents for the Colonies, 4 Millbank, Lond S.W.1, quoting M.N.18187/3F.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

B.I.O.S. Overall Report No. 17: The Jute Industry in Germa during the Period 1939–1945. Prepared by the British Jute Tra Research Association. Pp. 24. (London: H.M. Stationery Offi 1949.) 6*d.* net. [

British Museum (Natural History). Great Barrier Reef Expeditic 1928–29. Scientific Reports, Vol. 2, No. 9: The Seasonal and Vertic Distribution of the Copepoda. By G. P. Farran. Pp. 291–312. (Londo British Museum (Natural History), 1949.) 7*s.* 6*d.* [

Forestry Commission. Fifth British Empire Forestry Conferen Great Britain, 1947. Proceedings. Pp. 280. (London: H.M. Statione Office, 1948.) 10*s.* net. [

General Information concerning the Courses in Natural Science Oxford and Cambridge. Prepared for the use of Candidates Admission to the Women's Colleges. Pp. 12. (Oxford: B. H. Blac well, Ltd.; Cambridge: Bowes and Bowes, 1949.) 1*s.* net. [

British Standard 1460: 1948. Precipitated Calcium Carbona (Determination of Density after Compaction). Pp. 12. (Londo British Standards Institution, 1948.) 2*s.* net. [1

British Industries Fair 1949, Olympia and Earls Court, Londc 2nd to 13th May. Organised by the Board of Trade. Special Overse Advance edition. Pp. 576+Ad. 504. Advance edition, Alphabeti List of Exhibits in Foreign Languages. Pp. 144. British Industr Fair 1949, Engineering and Hardware Section, 2nd–13th Ma Organised by the Chamber of Commerce, Birmingham. Advan edition. Pp. 144. (London: Board of Trade, 1949.) [1

Other Countries

United Nations Educational, Scientific and Cultural Organizatio Report of the Director General on the Activities of the Organizati in 1948. (Unesco Publication 226.) Pp. 119. (Paris: Unesco, 194 7*s.* net. [1

Dialectica (International Review of Philosophy of Knowledg Vol. 2, No. 3–4: The Concept of Complementarity. Edited by Wol gang Pauli. Pp. 305–424. (Neuchâtel: Editions du Griffon, 194 4.80 francs. [1

Field Museum of Natural History. Zoological Series, Vol. 1 Part 1, No. 3: Catalogue of Birds of the Americas and the adjace Islands. Part 1, No. 3: Jacanidae—Rostratulidae—Haematopodida Charadriidae—Scolopacidae—Recurvirostridae, Palaropodidae-Burhinidae—Thinocoridae—Chionididae, Stercorariidae—Laridae-Rynchopidae—Alcidae. By Charles E. Hellmayr and Boardma Conover. (Publication 616.) Pp. vi+383. (Chicago: Field Museu of Natural History, 1948.) 4 dollars. [17

Sveriges Geologiska Undersökning. Ser. Ca, No. 36: The Alkali District of Alnö Island. By Harry von Eckermann. Pp. 176+ plates. (Stockholm: A. B. Kartografiska Institutet, 1948.) 10 kr. [2

Sugar Research Foundation. Scientific Report Series No. 11: T Chemical Production of Lactic Acid from Sugars. By Dr. Re Montgomery. Pp. v+28. Free. Science Looks at Sugar. Fifth Repo 1948. Pp. 23. (New York: Sugar Research Foundation, Inc 1949.) [2

Report of the Twenty-sixth Meeting of the Australian and Ne Zealand Association for the Advancement of Science, Perth Meetin August 1947. Pp. 365. (Perth: Government Printer, 1948.) [

Archiv für Meteorologie, Geophysik und Bioklimatologie. Herau gegeben von Dr. W. Mörikofer und Prof. Dr. F. Steinhauser. Serie A Meteorologie und Geophysik. Band 1, Heft 1. Pp. 141. (Wien Springer-Verlag, 1948.) [

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COLONIAL DEVELOPMENT AND WELFARE

THE full statement which the Minister of Food, Mr. Strachey, made in the House of Commons on the East African groundnut scheme on March 14 did not dispose of some of the criticism; on the whole, however, with some assistance from the Opposition, he succeeded in putting the scheme in its true perspective in terms of Colonial development. The public has hitherto regarded the scheme as essentially one to produce oils and fats, for which the fact that the Minister of Food was made responsible for the scheme was undoubtedly a contributory factor. The scale of the scheme is now to be reduced; but Mr. Strachey rightly refused to regard the production of oils and fats as unimportant. The world need of fat supplies is as great as ever, and whether or not the revised scheme will give, as is claimed, the same yield of oils and fats, the importance of that aspect remains, even if it is secondary to the main purpose of Colonial welfare and development.

Mr. Strachey stated that the acreage to be cleared in the three East African areas is to be reduced from three and a half to two millions, and that the Overseas Food Corporation estimates that, working to the ten-year plan, the new acreage will give the 600,000 tons of oil-seeds originally forecast. A higher yield would be made possible by including sunflowers in the rotation of crops. Development of the Kangwa area, where practically all the clearance has so far been done, will be restricted in favour of the more promising western area of Urambo and the southern area of Tanganyika; but Mr. Strachey advanced no evidence that better preparation has been made in the southern area, where admittedly no clearing has yet been done.

On such technical points there was surprisingly little comment in the debate in the House of Commons; but such factors will have a very important bearing on the expenditure involved. It was admitted by Mr. Strachey that the cost of the scheme may well be double the original estimate. That estimate may be accepted; but there will be less confidence in his estimate that revenue will also be doubled. Inflation has greatly exaggerated the world shortage of fats, and informed opinion is at least doubtful whether the price of groundnuts is likely to remain at the level of £51 a ton which the Ministry of Food is at present paying in its long-term contract for main supplies from West Africa. That price represents an increase of £6 a ton on the 1947–48 price, and, to say the least, it is unreasonable to expect the British taxpayer to permit the Minister of Food indefinitely to pay an inflated price in long-term contracts and ignore any fall in world prices.

Nevertheless, whatever the financial shortcomings of the scheme, Britain is now committed too deeply for it to be abandoned unless it is proved to be impracticable agriculturally. The best opinion is against so pessimistic a conclusion, and the reforms announced by Mr. Strachey appear to be sound. The revised plan will, however, require vastly improved methods of organisation if it is to succeed, and Mr. Strachey did not conceal the problems which are presented by such matters as stores, tractors and other equipment, and port and railway extensions. Much careful planning and preparation are needed, for these matters are not without bearing on other economic developments, as Mr. Strachey indicated in relation to the railway developments in the Lukeledi valley, which are to provide an outlet to the new port of Mikidani from the groundnut area.

The scientific and technical factors were chiefly stressed in the debate by Mr. Henderson Stewart, who rightly directed attention to the time required to be certain we had found the right solution to problems of cultivation, agricultural implements, the rotation of crops, fertilizers and so on. This speech drew from Mr. Strachey a repudiation of any suggestion that the Government had attempted to drive the Corporation or the managing agency at an unreasonable speed. But it must be recognized that long-term and short-term requirements are not always compatible; the Government has tended hitherto to overstress the short-term aspect of the scheme, and its reluctance to provide a report or 'white paper' in advance of the debate has not made it easy to correct that impression.

Two things at least the debate has done. From all sides of the House, members joined with Mr. Strachey in commending the personal devotion and enterprise of the Europeans working on the scheme in East Africa, and the debate should dispel any lingering ideas that criticism of the scheme should be levelled against those responsible for its execution in Africa. It was, indeed, suggested that the proportion of Europeans to Africans engaged in the scheme is considerably higher than originally envisaged—one to eleven instead of one to every thirty or forty Africans—and concentration of the Europeans on scientific, technical and supervisory tasks to the maximum extent should reduce the administrative and overhead costs. Mr. Frederic Harris also suggested that splitting up the 30,000-acre units into units of 5,000–8,000 acres for private development was a sensible proposition which should also be tried.

Above all, the debate brought out the welfare aspect of the scheme. The Minister of Food spoke of the benefit which would accrue to the African peoples once the project is fully under way; already, he said, there is evidence of benefit to health through the improved nutrition of those participating in the scheme. He might, indeed, have said more about the difficulties of maintaining a steady labour force and the measures that will be required to overcome them. Nevertheless, it can no longer be pretended that the scheme is one of exploitation of African resources for the benefit of the rest of the world; it is essentially a long-term development scheme in which the primary purpose is Colonial welfare, while simultaneously serving the world's needs for oils and fats.

The welfare aspect must, indeed, be kept in mind if the economic aspects of the scheme are to be considered fairly, whether from the point of view of the Colonial people or of the British taxpayer. The debate is one, therefore, to be considered in the context of a subsequent debate on Colonial policy and administration in the House of Lords on April 1 Against this background, too, should be reviewed th recent reports from the Colonial Office on the pro duction of fish in the Colonial Empire and on th work of the Colonial Primary Products Committee A large part of the latter report, in fact, deals wit vegetable oils and oil-seeds and with essential oil and in introducing the report the Committee refe particularly to the bearing of price, particularly o the production of oil-seeds.

Before the Second World War, the primary produce was often penalized by fluctuations in commodit prices on world markets. Marketing schemes established during the War for various Colonial product often paid producers a fixed price for the whol season, and producers of annual crops were guarantee prices for their produce before the planting seaso began. Since the assurance of a reasonable pric tends to encourage the planting of annual crops, continuance of such schemes, suitably modified, shoul increase production; and the system has the furthe advantage that central organisation can accumulat funds at times of high prices and subsidize prices pai to producers when world prices fall, thus cushionin producers to some extent. The Colonial Primar Products Committee in its report welcomes the polic of long-term contracts pursued by the Government particularly for tree crops and where capital development is involved. Quoting the text of the statemen made by the Chancellor of the Exchequer on September 17, 1948, in regard to such guarantees fo Colonial produce, it suggests that similar considerations might govern the conclusion of contracts fo commodities bought by other control buying organisations or associations of users or manufacturers.

It does not appear, however, that Mr. Strache has yet fully appreciated the implications of th Chancellor's observations on price, or on the imperative need for establishing beyond question communit of interest and co-operation if misunderstandings ar not to arise and justice is to be done between th primary producer and the ordinary citizen of Grea Britain. Moreover, as the Colonial Primary Product Committee has noted, where a crop such as oil-seed in West Africa is largely a cash crop, high prices will not result in increased production if there is a shortag of consumer goods. Lord Swinton did well to explain, in opening the House of Lords debate, the interdependence of economic prosperity, health and practical education in the Colonial areas, and the way in which the needs of the Colonial peoples are linked with the needs of people in Britain.

The commodity studies presented in this second report from the Colonial Primary Products Committee are reviewed elsewhere (p. 898 of this issue); it is sufficient here to note that the Committee takes the view that semi-mechanized methods for the cultivation of such crops as groundnuts and sunflowers are unlikely to be introduced rapidly into West African territories. It will probably be necessary to start with pilot schemes, the results of which must be available before production can begin on a larger scale. Similarly, experiments on a large scale over a period of years will be required before any ound conclusions can be reached as to the possibilities or groundnuts in British Honduras.

The improvement of material conditions must learly come first, and the debate in the House of ords brought out the need for a coherent and onsistent policy in Colonial administration. Without hat, neither British nor Colonial scientific workers, even with the help of American technical experts, ill secure the physical development of mineral ealth or other natural resources, water supplies or ransport, or the improvement in health and social elfare which could follow the application of advances n knowledge of nutrition, preventive and curative nedicine and the like. There must be a balance between such measures and those taken in the conomic and political field.

Lord Swinton, at the outset of his speech, enunciated five principles which should guide British Colonial policy and the planning of Colonial development. First, we are trustees for the whole of the Colonial peoples and not for a section or a minority. Secondly, the primary need of all these peoples is improved health and well-being, and the true liberty of he individual to enjoy them. Thirdly, economic and social progress depends on co-operation between the European and the indigenous populations. Fourthly, he ultimate goal is self-government, the evolution of which may be infinitely varied ; and last, that the prerequisite of self-government is the capacity to govern.

These five points were accepted on behalf of the Government both by Lord Pethick-Lawrence and by Lord Listowel. Nevertheless, there remains some doubt whether in practice the tempo of political development is quite in keeping with the first and last points, and whether there is not danger that too much regard is being had to the demands of a more vociferous minority. As Lord Swinton said in amplifying his last point, without effective government here can be no freedom for the individual, and while all suffer, the ordinary man suffers most.

It will not, and cannot, be easy to arrive at a balance which will satisfy all, and the balance must be struck for each territory in the light of the circumstances which prevail there. The Colonial Office tends to be over-cautious and, although sections of the ocal population may be over-eager or over-sensitive in the matter of political independence, the Colonial Office must none the less show more imagination and the leadership which inspires confidence. The points made by Lord Swinton provide some guide in working out a practical policy, particularly when three important points stressed by Lord Tweedsmuir are also remembered. Political independence can only come about when economic independence has been secured, and only then when the capacity for government exists. In all African Colonies and in many others, the Colonial peoples cannot make headway at present without European leadership, and European capital and technical help ; and that help will count for nothing unless we can take some Colonial peoples along with us in partnership. The second of those points was strikingly emphasized by Dr. C. H. Northcott in his recent report on the efficiency of African labour.

Hence Great Britain has still a great part to play in the future of the Colonial peoples, and it is important that at the centre there should be clear and constructive leadership, and that malicious criticism frequently levelled against Great Britain and other Colonial Powers should receive a positive answer. The United Nations Scientific Conference on the Conservation and Utilization of Resources meeting this summer at Lake Success will provide emphatic evidence of the British contribution to Colonial welfare. An even more important contribution of the Conference may be in furthering both the indispensable co-operation between the Colonial Powers and the Colonial peoples, and in shaping regional and other forms of co-operation between the Colonial Powers which will enable scientific and technical advances to be brought most swiftly and effectively to bear on the economic and social problems of the Colonial peoples. Nothing in Lord Listowel's reply was more welcome than his recognition that education is the vital social service, and that teaching people to govern themselves in local communities provides the real basis of political advance.

PROBLEMS OF ORGANIC FORM

Organic Form and Related Biological Problems

By S. J. Holmes. Pp. vii+169. (Berkeley and Los Angeles : University of California Press ; London : Cambridge University Press, 1948.) 27*s.* 6*d.* net.

THE title of this book is aptly descriptive of the contents. In a series of related essays, the author has discussed the factors which determine form in living organisms. It is difficult to do justice to a work such as this in a short review, for the author has succeeded in saying so much, and that with an illuminating perspicacity, that is cogent in each of his condensed chapters. These are concerned with an inquiry into the problem of organic form, the functional aspect of morphogenetic processes, competition as an integrative factor in morphogenesis, differentiation, chemical equilibrium and organic integration, and so on. On each theme, the leading ideas that at one time or another have been held are clearly set out, and an attempt is made to find a sure way to explanations of a valid kind. In these discussions the author's fairness and balance are a striking feature ; his contribution is patently the result of long and deep pondering of central themes in contemporary biology.

In every normal embryonic development the impressive facts are the formation and divergent development of the component parts or organs, their regular appearance in their proper positions, and the regulation and harmony of morphogenetic processes that result in the characteristic development of the whole. How are these phenomena to be explained, and what kinds of explanation are likely to prove acceptable to the contemporary biologist ? On such problems much new light is shed by the analytical approach adopted in this work. In the author's view, morphogenetic and related processes can be referred to biochemical and biophysical processes which are ultimately gene-controlled, that is to say, an epigenetic and mechanistic view of formative processes in plants and animals is upheld, the genes themselves being seen in relation to the evolutionary background. As a sample of the author's style, reference may be made to his chapter on "Genes *versus* Gradients": "If a viable organism is to be made, its parts must be of the right kind, in the right place, and appear at the right time. If oaks, oysters, grasshoppers, and elephants all owe their initial patterns to their metabolic gradients, we must look to other factors to account for the marvellously co-ordinated processes that give rise to these very different styles of organic structure." The decision is heavily in favour of the genes as the physiological agents chiefly involved: "As more becomes known about the relative roles of genes and cytoplasm in heredity and developmental physiology, the more basic the influence of genes is found to be".

Other chapters deal with cancer as a biological problem, the idiosyncrasies of direct adaptation, autocatalytic enzymes and the origin of life, and recapitulation and its supposed causes.

There can be no doubt that in these papers the author has made a significant contribution to modern biology. He has succeeded in giving a clear impression of the aims and outlook of the experimental biologist and in showing how adequate, on the whole, such an outlook can be.

SOUTH AMERICAN BOTANY

La vegetación del nordeste de la Provincia de Entre Ríos

Informe cientifico. (The Plant Cover of the North-east of the Province of Entre Ríos: Scientific Report.) Por P. G. Lorentz. Second edition. Pp. xi+180+xiii+3 plates. (Paraná: Talleres Gráficos Pattarone y Sors, 1947.)

Observaciones sobre la vegetación de la Provincia de Tucumán

(Observations on the Vegetation of the Province of Tucumán.) Por G. (J.) Hieronymus. (*Mon. Inst. Est. Geogr. Univ. Tucumán*, No. 5.) Second edition, revised and with critical notes by Hans Seckt. Pp. 162. (Tucumán: University of Tucumán, 1945.)

Esquisse de mes voyages au Brésil et Paraguay, considérés principalement sous le rapport de la botanique

(Sketch of my Travels in Brazil and Paraguay, with special reference to the Botany of those Countries.) Par A. de Saint-Hilaire. (*Chronica Botanica*, Vol. 10.) Pp. 61. (Waltham, Mass.: Chronica Botanica Co. London: Wm. Dawson and Sons, Ltd., 1946.)

THE work of the botanical pioneers in South America appeared for the most part in the form of pamphlets or monographs which soon became exhausted and inaccessible to later generations, or else it was published in equally inaccessible, obscure periodicals. Most of it was, however, work of great importance and the foundation upon which subsequent research, at all events for certain regions, has been built. For this reason the recent re-publication of some of the outstanding earlier work is a welcome addition to the botanist's armoury, and it is to be hoped that more will follow.

The last to appear has been P. G. Lorentz's classic report on the plant cover of the Argentine Province of Entre Ríos, first published in 1878 and now r issued by the Municipal Cultural Commission o Paraná and the Museum of Entre Ríos at the decre of the Provincial Government. The reproduction i an exact one, without any kind of correction, an reflects faithfully the conditions under which Lorent was working, conditions described also by J. F Báez, who writes the introduction and an appendix Lorentz had the entire goodwill of the Argentin Government of his day and every material assistanc that it was able to afford him; but the nationa exchequer had been so greatly impoverished as result of revolution and counter-revolution that th botanist, fresh from the well-equipped universities o Germany, described himself as "a scientific Robinso Crusoe", lacking the most elementary scientific equipment and especially hampered by the lack of books He was, in addition, dogged by persistent ill-healt which cut his career short in 1881. But his affectio for the country of his adoption was great and hi enthusiasm for his work unbounded, so that, lecturin during term-time at the College of Concepción on th River Uruguay, and, accompanied by some of hi students, exploring the countryside on horseback i the vacations, he assembled an enormous mass o material and information. Most of this is crystallize in the book now reproduced. When for lack of work of reference Lorentz was unable to classify plant himself, he sent them to Prof. Grisebach, of Göttingen for identification.

The work has three chapters. The first (pp. 3–47 contains a general description of the flora of such o Entre Ríos as Lorentz had been able to explore u to 1876. This embraced the north-eastern part from Concepción northwards as far as the junction of the Rivers Mandisobi Grande and Mandisobi Chico, and part of the woodland known as the Montiel. Some of the account takes the form of a diary describing a tour made in 1876. Practically the only form of use to which the country was put in Lorentz's day was a haphazard type of stock raising; but he was impressed by the fertility of the land and foretold a great future for the Province if at least a part o it were devoted to cropping. This has now taken place, and photographs published by J. L. Rich in "The Face of South America, an Aerial Traverse" (New York, 1942) clearly display a land of well-watered plains or gently undulating land with rich black soils, a large proportion of which are occupied by various cultures.

The second chapter (pp. 49–102) lists 620 species of flowering plants and 32 fungi collected by Lorentz and identified by him or by Grisebach of Göttingen. Notes are given on habitat, popular name, flower colour or other salient characters, growth habit, time of flowering, and in some cases the uses of each species. The achievement was a remarkable one. Until the arrival of Lorentz in Argentina, said Holmberg as quoted by Báez, the flora of that country consisted not of plant species but merely of grass and timber.

The third chapter (pp. 103–180) is entitled "Phytogeographical Relations" and compares the flora of Entre Ríos with that of the interior. For the interior, 100 families, 451 genera and 960 species are recorded, for Entre Ríos 98 families, 346 genera and 620 species. The flora of Entre Ríos is considered poor in relation to the geographical position, climate and soil of the Province, the poverty being attributed to the youth of the country. A list of 1,481 Argentine plant species is given (pp. 124–157), with notes of their presence or absence and frequency in Entre ios, the interior *monte* or scrub forest and the sub-opical parts of Argentina respectively, and the gional affinities and differences noted are discussed. he Entre Ríos flora is distinct and independent, onstructed on the same plan as that of the *monte* and the sub-tropical regions, but with different lements. It would probably not be equally independent if compared with the flora of southern razil. Natural plant colonization in Argentina is principally from the north.

A contemporary of Lorentz in Argentina was another German botanist, Georg Hieronymus, who as professor of botany in the University of Córdoba; and the two collaborated in collecting and classifying large amount of botanical material from Central rgentina. It is on the results of their joint work that many of Lorentz's conclusions recorded above ere based. Like Lorentz, Hieronymus did not conne himself to the systematics of the Argentine flora, but was intensely interested in its distribution as overned by climatic and environmental conditions. He published in 1874 a treatise on the plant cover of the Province of Tucumán, which was the foundation f all subsequent botanical work on that region; but or many years it had become quite unobtainable for the ordinary worker and was difficult to find even in braries. Its republication by the Institute of Geographical Studies of the Tucumán University, therefore, has satisfied a real need. Although its general terminology has been modernized by the reviser, H. Seckt, who has also supplied critical notes n Hieronymus's taxonomy, but without changing the ames used, the work remains practically unaltered nd is entirely pertinent to present-day conditions. An introductory chapter lists some fourteen different ormations which make up the plant cover of Argentina generally, and those found in Tucumán are enumerated in the next chapter. Subsequent chapters ive a detailed account of the different types of rassland found in the eastern plains of the Province, f marsh vegetation and water plants, of the different ypes of forest and woodland and their components (pp. 56–128), and finally of the mountain plant ormations with no characteristic tree growth but a ward composed of grasses in association with shrubs nd herbaceous plants. A map of the vegetation is ppended, drawn in accordance with the formations s described by Hieronymus.

The third reprint to which attention is directed here is the reproduction in *Chronica Botanica* of the introduction to Auguste de Saint-Hilaire's great work n the plants of Brazil and Paraguay, published in 1824 and, according to Castellanos and Pérez-Moreau's bibliography of botanical works on Brazil *Lilloa*, 7, 431; 1941), the earliest study of the Brazilian vegetation except one published by Spix and Martius in 1823.

The area traversed by Saint-Hilaire in 1816–22 was small in relation to the whole, vast extent of Brazil; ut it was representative and enabled him in this 7-page introduction alone to give a picture of most f the characteristic Brazilian plant formations and f the flora of Uruguay and the east of Paraguay. Before the advent of the French explorer practically nothing was known of the flora and fauna of these egions. Among interesting descriptions may be noted those of the typical Brazilian bush named *caatinga*, of the *sertão* or hinterland of Minas Gerais, and of the Uruguayan grasslands, of which he says: "Nowhere, perhaps, do better pastures exist". To Lorentz in Argentina the results of civil dissension were ever-present in the form of straitened means and the depleted animal population of Entre Ríos; to Saint-Hilaire in Uruguay and the La Plata region they were manifest in the amazing spread of weed growth and especially of the European *Cynara cardunculus*. Before the war which had just taken place, he wrote, the young shoots of this plant were eagerly grazed and the plant itself was prevented from spreading unduly, but with the war-conditioned destruction and loss of cattle all limiting influences were removed. "*Cynara cardunculus* to-day covers immense terrains; it makes them useless for cattle and horses and it will be an indestructible monument of the civil discords which have rent this fair country." It is only now, more than a century later, that Uruguay is beginning to see an end of this weed problem, one valuable solution being the cutting of *C. cardunculus*, *Silybum marianum* and similar weeds for silage. The silage produced is highly nutritive, and the cutting tends to clear areas of the undesirable plants and to make room for better (A. Boerger. "Investigaciones agronómicas." Vol. 2. Buenos Aires, 1943). An introductory essay by Anna E. Jenkins precedes the reproduction of Saint-Hilaire's work.

G. M. Roseveare

ADVANCES IN ELECTRONICS

Advances in Electronics
Edited by L. Marton. Vol. 1. Pp. xi+475. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 9 dollars.

THE "Reports on Progress in Physics" have always fulfilled a valuable function in acquainting the specialist in any one of the physical sciences with progress in cognate subjects. These "Reports" cover the whole range of physics, and it was felt that electronics, though a part of physics, so spilled over into electrical engineering and had grown to such a size that a volume of review articles confined to electronics was needed. Dr. L. Marton, now of the Bureau of Standards, has undertaken this task as editor, and the first volume has just been published. Although this is an American publication, it intends to draw freely upon European men of science for review articles, and already plans for volumes 2 and 3 include a number of British contributors. Volume 1 is written entirely by American men of science, but this was due to the difficulties encountered in launching the new venture.

In the preface, Dr. Marton points out that "Advances in Electronics" will be confined to the physics of electrons in the free state—emission, space-charge effects, interaction, etc.—and to the engineering applications of a fundamental character, avoiding so far as possible discussion on instrumentation and circuitry. The contents of volume 1 certainly bear out the policy he outlines.

Electron emission is dealt with in two long articles, A. S. Eisenstein on "Oxide Coated Cathodes", and K. G. McKay, of Bell Telephone Laboratories, Inc., on "Secondary Electronic Emission"; both are most exhaustively treated with what appear to be complete bibliographies over the past decade. Eisenstein's review brings up to date J. P. Blewett's 1939 résumé of the subject, and includes the important war-time research on cathodes in magnetrons and valves pulsed for times of the order of microseconds.

The results of this work focused attention on the importance of the interface between the base metal and the oxide layer, and a whole section of the review is devoted to our present knowledge of the interface and its probable rectifying properties. A further important section reviews the known properties of the complete cathode, and includes the probe experiments and the phenomenon of sparking, all of which have only been reported upon since the War. McKay divides his subject into emission from pure metals and emission from insulators, and includes a summary of early work, since the standard reference hitherto has been in German. It is interesting to learn how little modern work has been done on the velocity of emission of secondary electrons, a field obviously ripe for further exploration. Practically the whole of the long section of the emission from insulators is based on research published since 1939 and is of great importance.

R. G. Hutter contributes an original article on the deflexion of beams of charged particles, a subject which has received far less attention than the focusing of beams by lenses; he deals with single and double electric and magnetic deflexion, with large-angle deflexion, and with the many mixed deflexions in mass spectrometers. M. G. Inghram, of the Argonne Laboratory, supplements this with an article on mass spectroscopy, in which the use of the spectroscope is treated. It was surprising to find no mention of the calutron in an article on mass spectroscopy.

The television pick-up tube has become a third method of visual examination supplementing the eye and the photographic plate. Apart from use in the entertainment world, the television tube has an important future in the research laboratory, and men of science will turn to A. Rose's article on "Television Tubes and the Problem of Vision" to find out the ideal performance of tubes and the degree to which present-day tubes achieve this ideal.

The last article on particles is a review by M. S. Livingston on "Accelerators"; but for readers in Great Britain there is already a recent review in the current "Reports of Progress in Physics", which practically covers the ground.

The importance and fickleness of the ionosphere and the irritating habits of the cosmos are treated by A. G. McNish in "Ionospheric Research" and by J. W. Herbstreit in "Cosmic Radio Noise"; both men work in the Bureau of Standards, and their reports cover almost exclusively the post-1939 research. McNish points out that much more data are required on a world-wide basis, and a comprehensive theory of the ionosphere which will explain the complex features discovered during the War is needed. Cosmic noise has been shown to be so important that the lowest usable field intensity for radio communication is set by it. Its origin is still obscure, and the study of cosmic noise is another approach to the understanding of the heavens.

"Propagation in the FM Broadcast Band" is reviewed by K. A. Norton. It may come as a shock to readers that, within a year, the frequency-modulation broadcast stations in the United States will probably exceed the pre-war number of conventional amplitude-modulation stations, and a review of the factors which influence frequency-modulation propagation is most timely. Frequency-modulation avoids to a large extent the interferences reviewed in the two previous articles; but Norton emphasizes that we are still only beginning to learn about propagation characteristics in the frequency-modulation band—nc set at $\sim$ 100 Mc. in the United States. The artic will be eagerly read in Great Britain by advocat and opponents of the system.

The last article is by J. A. Pierce, on "Electron Aids to Navigation", and includes all the war-tim developments in this subject; but the article do not carry a single reference, so that the resear worker will not be in a much better position f further study.

The book is very well presented and appears have few blemishes. If future annual volumes are good, the "Advances in Electronics" will have important place on our bookshelf.

T. E. ALLIBONE

THE BADGER AT HOME

The Badger

By Ernest Neal. (New Naturalist Monograph Series Pp. xv + 158 + 25 plates. (London and Glasgow Wm. Collins, Sons and Co., Ltd., 1948.) 12*s*. 6 net.

THIS monograph on the badger by Ernest Ne is, I think, the best book that has been publishe on this nocturnal animal. The author has a literall astonishing knowledge of the badger and its habit and he is able to set down this knowledge in a attractive form and in good and readable prose. Th reader with him visits the badger's setts, and the watches the fascinating chapters in the animal's lif He sees a badger emerge from the sett or earth, scratc himself, romp with his mate, and call out the youn ones.

Knowing the animal as he does, Mr. Neal is in strong position when he puts in a plea for the badge He cannot understand why it excites so great ani mosity, and says that it is a beneficial animal an should be protected, not destroyed. He says tha foxes habitually live in badger setts, and believes th fox is responsible for almost all the lambs presume killed by badgers and found near their setts. Does i kill poultry ? Yes, but rarely. Its food is youn rabbits (it has an uncanny faculty of finding these i the nest), rats and mice, snails, slugs and the like, an it does good by destroying many wasps' nests for th grubs, of which it is passionately fond.

The author is doubtful if the badger hibernates i Great Britain; they were, he says, active in thirty four degrees of frost on February 25, 1947. H mentions that, whereas the gestation period has bee put at twelve months, he considers it to be onl seven months, and gives careful reasoning to suppor his views. When he watches at a sett, the autho does his best to have a tree as a background, for h has found that a badger's sight is poor, and that i relies on its keen scent rather than on its sight t warn it of danger.

The book is illustrated by some beautiful an remarkable photographs; that forming the frontis piece, of a badger at night, is, I imagine, the firs colour photograph ever taken of this animal. Th author gives a map showing the places where th badger is most numerous, where it is scarce, an where it is not found. Is he right to give the Isle o Skye as one of the places where it is unknown ? I seem to remember that it haunts or haunted a smal wood at Kingsburgh in that island.

SETON GORDON

nnual Review of Microbiology

harles E. Clifton, Editor ; Sidney Raffel, Associate ditor ; H. Albert Barker, Associate Editor. Vol. 2. p. viii+532. (Stanford, Calif. : Annual Reviews, nc. ; London : H. K. Lewis and Co., Ltd., 1948.) dollars.

N this, the second volume of a new series of annual reviews, an attempt is made to survey major spects of the vigorous and ever-widening field of nicrobiology. Broadly speaking, the matter pre- nted ranges over the physiology, pathogenicity and enetics of fungi, bacteria, protozoa and viruses ; ut particular themes such as antibiotics, the nature f antibodies, the inheritance of immunity, the mode f action of therapeutic agents, nitrogen fixation, hemical disinfectants and the microbiology of soils, rinking water and sewage, have also received atten- on. In a work which is intended to provide up-to- ate information over a wide field, it would be vidious to pick out particular essays for special ention ; indeed, as some of them run to forty or fty odd pages, it would be difficult to do justice to ny one of them in a short review. The reader is, owever, assured of a wealth and diversity of inform- tion both in the text and in the comprehensive ibliographies.

Differences of opinion doubtless exist as to the ontent and function of annual reviews. Those of he kind under consideration tend to be of the nature f compilations—in the preface the editors refer to the task of compiling critical and, at the same ime, comprehensive reviews". While the several apers included in the annual volume afford an dequate account of what is going on in particular ields, there can be little doubt that they will gain in alue in so far as the attempt is made not only to arry out a paper-to-paper survey, but also to pick ut and emphasize the major contemporary lines of dvance and to summarize briefly the main con- lusions which have been reached or to which the ew discoveries point.

The Failure of Metals by Fatigue

roceedings of a Symposium held in the University f Melbourne, December 2nd–6th, 1946, under the egis of the Faculty of Engineering. Pp. xvi + 505. Melbourne : Melbourne University Press, 1947.) 2s. net.

THE holding of symposia to discuss present views on a particular subject is becoming increasingly opular. Each provides the occasion for pooling vailable scientific knowledge in a particular field, to he great convenience of individual workers on the ubject. The main benefit, however, as Dr. H. J. ough says in his foreword to this volume, is in the rovision "of a spring-board from which valuable esearches will be launched".

Thirty papers read at a symposium in Melbourne n December 1946 are here collected. Two-thirds of he papers are by Australians, but the names of . G. Pugsley, U. R. Evans and H. O'Neil are among hose from Great Britain, with H. F. Moore and G. achs among the contributors from the United States. While the papers are generally of high quality, there is no important new contribution to our basic understanding of the phenomenon of fatigue. The papers give practical examples of the occurrence of fatigue failure in specific service conditions, analyse the conditions promoting reversed stresses of sufficient intensity and suggest methods by which failures could be avoided. Important summaries of our knowledge of the mechanism of fatigue failure are included, and there are papers on testing techniques which, although in some cases on the fringe of the field of fatigue failure, are nevertheless of considerable importance in its understanding or its investigation.

All papers are not of the same high level (for example, the writers on fatigue failures of lead cable sheathing seem inadequately informed on previous British work in this field), but the book is one which justifies the considerable trouble that the promoters of such a symposium must have taken. The absence of an index is deplored.

G. L. Bailey

Inorganic Process Industries

By Prof. Kenneth A. Kobe. Pp. vii+371. (New York : The Macmillan Company ; London : Macmillan and Co., Ltd., 1948.) 30*s*. net.

THIS book is intended to impress on students the importance of following the evolution of an industry and of keeping abreast with modern developments by studying the literature. The first chapter gives a very comprehensive method of studying the literature. The remaining nine might better be entitled "Some Inorganic Industries in the United States", and consist of a series of descriptive articles, each of about 40 pages, on the main heavy-chemical industries. These are presented in a historical manner, contain no references, and do not emphasize new developments. At the end of each chapter a number of articles is listed as a recommendation for students to read. These are almost exclusively of American origin. Except for a few historical references, the subject-matter is confined to the manufacture of sodium and potassium salts, chlorine, sulphuric acid, and nitrogen and phosphorus compounds in the United States ; and the book can scarcely be expected to appeal to British readers, in spite of an admirable set-up, clear diagrams and good printing.

H. E. Watson

The Works of George Berkeley, Bishop of Cloyne

Edited by Prof. A. A. Luce and Prof. T. E. Jessop. (Bibliotheca Britannica Philosophica.) Vol. 1 : Philosophical Commentaries, Essay towards a New Theory of Vision, Theory of Vision Vindicated. Edited by Prof. A. A. Luce. Pp. viii + 280. (London and Edinburgh : Thomas Nelson and Sons, Ltd., 1948.) 30*s*. net.

THIS first volume of the new complete edition of the works of Berkeley is most welcome and is a handsome well-produced book worthy of its subject. Fraser's editions of 1871 and 1901 have been useful, but have some serious defects. Fraser discovered the notebooks containing Berkeley's "Philosophical Commentaries", but failed to see that they had been bound together in the wrong order. His transcription was not always accurate. Prof. Luce's magnificent edition of 1944 put right these defects and provided invaluable notes. He here reprints the "Commentaries" in handier form with shorter notes, sufficient for explanatory purposes. The "New Theory of Vision" never presented serious textual difficulties ; but Fraser did not distinguish properly the alterations made by Berkeley in his life-time and does not appear to have used the last version. Prof. Luce reprints this fourth and last edition, indicating all alterations. In his introduction, while stressing the permanent value of this work of Berkeley, he mentions a point often forgotten, namely, how much it owed to the influence of Molyneux.

The "Theory of Vision Vindicated" is here for the first time available in a really intelligible form; Fraser unfortunately used a very imperfect version that had been printed by Cowell. This short work of Berkeley is valuable because it effectively corrects the false impression sometimes produced on modern readers of the "New Theory of Vision". That was the first thing Berkeley published; it embodied a strictly technical discussion of the processes of sense perception; it was a necessary preliminary to his philosophy, but did not require its explicit statement. Had he introduced the novel conceptions and the terminology of his "Principles", to be published in the following year, his first readers would have been confused. Berkeley's care for the difficulties of his contemporaries created difficulties for later readers. These, knowing the views of the "Principles" and finding apparently contrary views in the "New Theory", have often accused Berkeley of inconsistency. Anyone who takes the three works in this volume together will see that there is no inconsistency. A. D. R.

Weather Forecasting

By Instructor-Comdr. S. W. C. Pack. Pp. 192+8 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 25*s*. net.

INSTRUCTOR-COMMANDER S. W. C. PACK is concerned more with the fundamental bases of synoptic meteorology than with the actual details of weather forecasting. As a grounding, his book is comprehensive, beginning with the structure of the atmosphere and, briefly, meteorological instruments, and continuing with a good deal of climatology, which is an essential background to all weather forecasting. Incidentally, the thermometer at Blackadder which recorded a minimum of −23° F. was *not* conventionally exposed. The chapter on "Fronts" and the development of depressions is on the usual lines; but wind in relation to pressure gradient is more clearly demonstrated than is usual in text-books. The most detailed and best part of the book is the treatment of adiabatic changes, dry and saturated, and the discussion of the tephigram and its uses in determining stability or instability; this should make a difficult subject clear to most students, as should also the later chapter on the variation of wind with height. The chapter on analysis and forecasting covers only eleven pages and is disappointing; there is no actual example of the analysis of a chart, either at ground-level or in the upper air. The book is well illustrated with photographs and clear diagrams, but seems high-priced for its size.

A Statistical Analysis of Advertising Expenditure and of the Revenue of the Press

By Nicholas Kaldor and Rodney Silverman. (National Institute of Economic and Social Research, Economic and Social Studies, 8.) Pp. xiv + 200. Cambridge: At the University Press, 1948.) 15*s*. net.

THIS book arose from a proposal made to the National Institute by the Advertising Association that an impartial inquiry should be made into the economic effects of advertising. The authors have carried out a very difficult task with extreme competence and are to be complimented particularly on their method of presentation. The main emphasis has been placed on the period 1934–38, with the result that we now have a comprehensive statistical survey of advertising expenditure in the United Kingdom for the pre-war years. Figures relating to the revenue of the Press extend to more recent years—up t 1944.

This is a most interesting example of what can b achieved when a research body has the full co-operation of professional and trade associations, togethe with the support of individual firms. Analyses of thi nature will be of particular interest to the historia of economics, and it is to be hoped that they will b repeated at regular intervals in the future. The mai findings are clearly summarized in the first part o the volume in order to save the time of the les statistically minded reader, and the authors hav wisely refrained from detailed comment, leaving th facts to speak for themselves. The second part i devoted to a detailed description of the methods b which the various estimates have been made Consequently, the book can be strongly recommende to students of economics, not only for its subject matter but also for the insight which it gives int methods of approach.

In passing, it is interesting to note how handicappe the investigators were in the absence of a census o distribution. One small criticism is that man references are made to sources of information. Whil most of these are to be found among the index, i would be helpful to the specialist reader if in subsequent edition they were to be listed in bibliography. E. C. DANIELS

Le Bartonien du bassin de Paris

Par L. et J. Morellet. Pp. viii + 437. (Paris Service de la Carte géologique, 1948.) N.p.

LUCIEN MORELLET, whose death occurred i 1945, was one of the many distinguished Frenc geologists who have devoted their attention to th richly fossiliferous Eocene deposits of the Paris Basin In collaboration with his brother, Jean Morellet, h studied especially the calcareous algæ, on which h was recognized as a world-wide authority, and th Parisian Eocene strata above the Lutetian. Th results of more than forty years of observations and collecting by the two workers on this latter subjec have now been edited and arranged by M. J. Morellet and issued as a memoir of the Service de la Cart Géologique.

This study lists and describes in detail, with copiou fossil lists, almost all sections in the Paris Basin 'Etage Bartonien', many of which have been long since obscured, discusses the significance of the fauna and flora with regard to palæogeography and climate, and reviews the history of the classification and correlation of strata at this horizon. In coming to a decision on this vexed question, the authors are wisely tolerant, recognizing the difficulties inherent in the study of these variable strata, and admitting frankly that it is unfortunate that 'Bartonien' was initially proposed for Parisian strata and not for the familiar Barton Beds in England. If it is too much to expect that all students of the Eocene will agree with their 'Bartonien' covering all Eocene beds above the Lutetian in France, and ranging in England from the base of the Upper Bracklesham to the top of the Lower Headons, the supporting evidence and common-sense nature of the final decision for a single stage are obvious, even if the name retained is unwise.

Meanwhile, the volume is a magnificent detailed record of a type-area invaluable to all students of the older Tertiary, and a fine memorial to the life-work of L. Morellet and the long collaboration between the two brothers; M. J. Morellet is to be congratulated. G. F. E.

STRUCTURE AND ACTIVITIES OF THE BACTERIAL SURFACE

ON April 20 the Society for General Microbiology held a symposium on "The Nature of the Bacterial Surface". Seven contributions and two urveys by the chairmen had been printed and irculated to members of the Society before the meeting. On the assumption, which proved to be well founded, that these had already been read by hose attending the symposium, most of the time of he meeting was spent on discussion. Argument had o be restrained rather than promoted by the chairmen, and it ranged over a wide but relevant field; although the meeting was extended beyond the time arranged, it finished with several members still wishing to speak.

There was general agreement on many subjects. Several speakers pointed out that the microscopically visible capsule is dispensible and that there are no definite divisions between the successive layers by which the cell is surrounded; these views were not controverted. Opinion varied over the extent to which electron-micrograms give direct evidence about the original material that is being examined; but, after some years of rather uncritical acceptance of electron-micrograms at their face value, it was refreshing to find that there was general awareness that changes can take place during the preparation, drying and shadowing of a specimen. Finally, the suggestion that the macroscopic properties of films, fibrils and threads are not an infallible guide to the properties of similar, but much smaller, structures, may be mentioned. No one postulated new properties of matter; but there was agreement that we should beware of arguments based on the extrapolation of the conventional properties of matter to bacterial appendages that may be only one-thousandth the size of structures that have already been thoroughly investigated.

Evidence coming from the serological properties of bacteria, and of antigens prepared from them, was considered by W. T. J. Morgan. He argued that the failure of a serological reaction does not necessarily mean that the structure which should have reacted is placed deeply in the organism; it could be near the surface but in a state of chemical combination that keeps it from reacting, or it could be surrounded by larger amounts of a more reactive antigen. In discussion, C. M. Chu stressed the importance of a serological study of the bacterial residue left after the mild extraction procedures advocated by Morgan. In this way more light might be thrown on the actual location of antigens which appear to lie on the surface.

A comprehensive picture of the chemical processes involved in Gram-staining, in the synthesis of capsular polysaccharides, and in the action of the pneumococcal transforming principle, was presented by M. Stacey. Harriett Taylor criticized this picture with logic and pertinacity. Stacey suggested that the deoxyribose nucleic acid, the presence of which promotes capsule formation by non-capsulated pneumococci, is contaminated by traces of capsular polysaccharide, and that this, by analogy with other cases where polysaccharide is needed as a starter for polysaccharide synthesis, is the effective substance. She agreed that the deoxyribose nucleic acid, like all large molecules, is probably contaminated, but looked on the capsular polysaccharide as one of the less probable contaminants. Stacey's suggestion that the Rough pneumococci have less nucleic acid on their surfaces than the Smooth, and that roughness results from growth under deficient nutritional conditions, she likewise emphatically rejected. There were repercussions of this disagreement in the discussion after Harriett Taylor's paper on pneumococcal transformation. It seems to originate in the orthodox chemist's unwillingness to accept the enormous number of specific nucleic acids called for by some biological evidence. Until we know something of the minimum size of these postulated active nucleic acids, and of the effect which a change in nucleotide sequence has on specificity, this unwillingness seems premature. It is easy to get the required number of isomers if every difference in sequence is significant. In Taylor's paper, examples had been given of deoxyribose nucleic acids made from different strains of pneumococcus that are chemically indistinguishable but differ biologically.

Work with the pneumococci suggests that the bacterium can at one time have only one type of capsule and one type of transforming principle—as if there is a single locus which can be occupied by only one type of transforming substance. A somewhat different form of 'exclusion principle' was described by D. McClean. Streptococci can have either hyaluronic acid capsules or they can secrete hyaluronidase, but not both. The addition of hyaluronidase to capsulated organisms decapsulates them, whereas the addition of hyaluronic acid to some streptococcal cultures stimulates the adaptive formation of hyaluronidase. We have here a fascinating field for studying the interplay of the biochemical factors on which the morphological and other properties of an organism depend.

Peter Mitchell considered the properties of the osmotic barrier. He was more concerned with what the barrier does and how it does it than with what it is made of and how thick it is. He showed that for many substances it cannot be regarded as a passive filter, acting by virtue of differences in pore size or partition coefficient, and suggested mechanisms by which osmotic work could be done in the barrier. In discussion, the problem was skilfully defined by K. A. Bisset, who contended that there is no reason to postulate any thickness for the osmotically active layer. In his view it may well merge with the cytoplasm of the cell and so have no defined inner surface.

The reaction between bacterial viruses and the cell involves a series of changes in the bacterial surface; T. F. Anderson discussed the conclusions that can be drawn from this line of evidence. His own work and Schlesinger's shows that the observed number of effective collisions between bacterium and virus agrees with the number theoretically to be expected with particles of these sizes. This means that, in spite of the specificity of the action, nearly every collision is effective. He suggested that this could come about if the first connexion is with a plastic structure on which subsequent rearrangement can take place or which, if this fails, can break off from the organism. With his group of viruses, so long as host and virus have not been deliberately inactivated, absorption only takes place on to cells capable of sustaining virus multiplication. The surface carries "frank, specific displays of its range of suitability as a host for the viruses to which it is sensitive". In the introduction, N. W. Pirie had stressed the lack of evidence that viruses penetrate the bacterial cell wall; their multiplication on, rather than within, the wall would be compatible with Anderson's evidence. As often happens when viruses are under consideration, the discussion took on a slightly metaphysical tinge. Felix urged a return to Bordet's view that bacterial viruses are fragments of the bacterial cell; but Anderson, because of the absence of serological relationships between the viruses and host cell constituents, saw no advantage in this hypothesis. A lysin can be made by ultra-violet irradiation of some viruses; A. Pirie asked if this should be looked on as an enzyme attacking a substrate in the cell surface or as an activator for the autolytic mechanism already present in the surface. Anderson said he did not know how often a molecule had to do the same job, without being destroyed, before it should be called an enzyme. There is no evidence that the substances postulated in these processes act more than once.

The part of the bacterium that is responsible for its mechanical integrity was only discussed briefly. I. M. Dawson showed electron-micrograms of the rigid cell wall made by centrifugal fractionation of a suspension of staphylococci that had been shaken with glass beads, and J. Smiles described the elastic properties of the membrane surrounding various organisms and of the septa which form before or during cell division. In different organisms these structures have characteristically different properties when subjected to stresses by flow of the medium or by drying. The general properties of these membranes were surveyed by E. T. C. Spooner from the point of view of the bacteriologist, but nothing was said about their chemical nature.

The last paper to be discussed was by A. Pijper, on bacterial motility, and this subject was also the main theme of A. A. Miles's introduction from the chair. Pijper contends that bacteria move by virtue of an undulatory or corkscrew movement of their bodies, and that the flagella are wisps of slime trailing in the medium. He does not deny the existence of flagella, but looks on them as the consequence rather than the cause of motility. Observations on living bacteria under dark-ground illumination with sunlight give the main evidence for this point of view, and some of the phenomena were illustrated by a cinematograph film. Here it appeared that the direction of movement of the body is the first thing to change, and that it is only after this has happened that the flagella move round to the rear of the moving organism. Pijper's view was hotly contested. T. Y. Kingma Boltjes thought the mechanics very improbable and preferred the conventional interpretation of motility. A. Fleming confessed himself nearly convinced, but found his own observations on the rotational movements of *Proteus* grown in the presence of penicillin more nearly compatible with the concept of active flagella. This movement only takes place when the specimen is illuminated, and it appears that, when the light is turned on, flagellar movement precedes movement of the organism. The uniformity of flagella in electron-micrograms, and especially the fact that in one organism (unclassified) two distinct sizes are seen, together with the constancy with which the same number of flagella are seen in the same place on the members of one species, seemed to A. L. Houwink to rule out the trailing slime hypothesis. A similar attitude was taken by W. van Iterson, who showed electron-micrograms of flagella apparently connected with the protoplast or with granules. Their formation from these structures would suggest that they are not formed by the casual streaming away of surface slime but are a specific extrusion. What is known of the chemistry of flagella makes such an origin probable. Conclusions about their origin do not, however, radically affect the problem of flagellar movement and, although Pijper's interpretation contains undoubted difficulties, no clear refutation of it was forthcoming.

It was generally agreed that this symposium was valuable, and that much of its value depended on the 'preprinting' of the main contributions. This technique is already used regularly by some societies; but its expense is bound to keep it from being adopted widely. It may therefore be legitimate to argue briefly the national economics of such meetings. Three hundred people attended this one, and at least two hundred of them were paid directly or indirectly out of public funds. The average of their salaries is certainly not less than £2 per working day. For an all-day meeting some are away for more than a day and many get travelling expenses. The hidden cost to the community of such a meeting is £500 at the lowest estimate, quite apart from the ordinary cost to the society. This expense is fully justified; but it is important to recognize that it is there, and to ensure that the best use is made of the time and money spent. If, by 'preprinting' the papers, we can increase significantly the value to the participants of the time spent in a meeting, it seems not unreasonable that the cost of 'preprinting', £100–£200, should be borne by public funds.

N. W. PIRIE

NATURAL PRODUCTS IN THE BRITISH COLONIAL EMPIRE

THE second report of the Colonial Primary Products Committee*, dated January 1949, consists mainly of a series of commodity studies, to which is appended a note by the Imperial Institute on distillation of essential oils, describing inexpensive plant for this purpose. Recommendations of the Committee in regard to groundnuts are discussed elsewhere (p. 889 of this issue); in regard to oil-palm products, the Committee recommends the introduction of a superior grade to encourage the production and sale for export of an oil suitable both for edible and technical purposes. The Committee considers that for coconut products a long-term assurance is of the first importance; but of other edible oils and oil-seeds yielding edible oils produced in the Colonial Empire, kapok seed, neem oil and dika fat are unlikely to be of use for edible purposes, special encouragement of sesame is not recommended, and of the minor oil-seeds only cottonseed and illipe nuts appear worth encouraging. The best hope of increased production of soya beans in the near future appears to lie in East and Central Africa, and the Committee hopes that the assured market will stimulate increased production there, and that departments of agriculture will pursue their variety trials. It suggests that if the large-scale trials of sunflowers as a rotation crop in Tanganyika prove satisfactory, consideration should be given to growing the crop extensively elsewhere. It also considers that every effort should be made to increase Colonial production of drying oils to reduce the gap between sterling demand and sterling supply, and hopes that the present acreage of linseed in Kenya will be maintained, if not extended. Attention is also directed to the considerable possibilities of the candlenut tree, *Aleurites moluccana*, as a native-grown permanent tree crop, and to the desirability of establishing trial plantings over a wide range of conditions. It is suggested that the Colonial Products Research Council should undertake decortication trials with samples of nuts with the view of evolving a suitable decorticator for Colonial conditions. Production in the Empire of tung oil is centred in Nyasaland, and if the yield from the Colonial Development Corporation's project in the Vipya Highlands materializes, together with production in the Southern Province in eight or ten years, much of the United Kingdom's demand should be met. Trials with the cultivation of high-yielding strains of castor giving non-scattering seeds are recommended, and also further trials of rubberseed oil and the cultivation of *Tetracarpidium Conophorum*. Encouragement of the cultivation of perilla, niger seed, chia oil, ongokea or isano oil, poy-ok oil and tee-seed oil is not recommended for reasons given.

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* Colonial Office. Colonial Primary Products Committee. Second Report, January 1949. (Colonial No. 238.) Pp. 60. (London: H.M. Stationery Office, 1949.) 1s. net.

The three main kinds of starch produced in the Colonies are arrowroot, sago flour and tapioca starch. There is every reason to increase the growing of arrowroot, and it is hoped that two grinding mills of an improved type will permit an increased yield to be obtained in St. Vincent from the root. Growing in Grenada is also proposed; but no unqualified recommendation is given for increased production of cassava for starch.

The Committee considered in detail the production and marketing prospects of a considerable number of essential oils; it recommends, however, stimulation or exploration of production only for cajuput, cananga and ylang ylang, eucalyptus, geranium, juniper, lavender, neroli, patchouli, peppermint, petitgrain, spearmint, thyme, vetiver or 'cus-cus' and wormseed. Of the citrus oils, the production of a better quality of grapefruit oil should be encouraged. New production of citronella oil would have to compete in well-established markets, and future production of cloves and clove-stem oil in Zanzibar and Pemba is likely to be affected by a serious outbreak of the 'sudden death' disease.

With regard to timber, the Committee considers that while it will be a long time before softwood production can be developed on a large scale, the hardwood exports of British Colonial territories are capable of very substantial expansion; but maximum production cannot be secured without a great improvement in the supply of machinery, in communications and increased staff. There is much scope for research in sylviculture and conservation, and especially on utilization. Maximum production depends on such matters as the increased conversion of timber from the log, particularly of secondary timbers, to economize on the freight of logs by transporting them in semi-processed form, and the development of veneer and plywood manufacture in the Colonies.

In regard to paper pulp, there are many products from which paper pulp of varying qualities can be made, but the number of economic materials is reduced by considerations of homogeneity, accessibility and certainty of supply. While there are a number of lines of inquiry, particularly into eucalyptus and wattle, which can be profitably pursued, the Committee believes there is at the moment no project which can be confidently recommended as a practical proposition. Reviewing the position of tanning materials, the Committee considers that owing to the war-time consumption of quebracho for fuel and the serious spread of disease among the chestnuts of South America, there is risk of a world shortage of vegetable tanning materials in the next twenty years if alternative sources of supply are not developed. Wattle is the most promising source of such materials in Colonial territories, and its cultivation should be encouraged, particularly on the highlands of East and Central Africa. The Committee also estimates that present schemes of development could increase Colonial production of tobacco by about fifty per cent, if the equipment, skilled labour, finance and fertilizers are forthcoming. While, however, the Colonies will continue to supply an appreciable part of the United Kingdom's requirements of pipe tobacco, they contribute to a very limited extent only to those of cigarette tobacco.

The Committee has also considered Dr. C. F. Hickling's report on "The Production of Fish in the Colonial Empire", since issued as Colonial No. 237*; it regards this report of the Fisheries Adviser to the Secretary of State for the Colonies as expressing adequately its own views. Dr. Hickling outlines the training now being given to some twenty-one fishery officers, and emphasizes the importance of studying methods of fish preservation with a view to their improvement by research. A fish preservation research officer is to be attached to headquarters, who will advise Colonial Governments as well as conduct research. A large sample of salted fish and of shark has been sent to the managers of the East African groundnut scheme for evaluation; and biological research on the fish taken in the survey of the Mauritius and Seychelles area of the Indian Ocean is also being carried out, and a biochemist has joined the survey. A West African Fisheries Research Institute is being established at Kessy Dockyard in Sierra Leone, and the scheme provides for long-term research on the productivity of the sea off West Africa. In Uganda, research is provided by the Fisheries Research Station at Jinja, and plans are being drawn up for a fisheries research station in Northern Rhodesia. Research in the South-East Asia region is to be provided for by a large research station, preferably at Singapore, which with its research vessel should cover the area from the Andaman Islands to North Borneo. A scheme has been approved for a centre for research and training in fish culture in Penang, Malaya.

Generally, it is considered that while there is considerable scope for increasing the Colonial production of fish, such increased production will be absorbed by the Colonies themselves, and except from the Gulf of Aden, Hong Kong and the Mauritius–Seychelles areas, surplus for export is unlikely. Increased production depends largely on the application of mechanized methods, which is hindered by difficulties in obtaining ships, equipment and trained staff. Although these deficiencies are being overcome, Colonial Governments must be prepared to make the necessary expenditure. Reference is also made to the development of by-products such as shark-liver oils, isinglass, and alginic acid and agar-agar from seaweeds.

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* Colonial Office. Production of Fish in the Colonial Empire. (Colonial No. 237.) Pp. 14. (London: H.M. Stationery Office, 1949.) 4*d*. net.

CHINESE CERAMIC GLAZES

WITH SPECIAL REFERENCE TO THOSE DERIVED FROM COPPER*

By A. L. HETHERINGTON, C.B.E.
Honorary Secretary of the Oriental Ceramic Society

THE Chinese potters employed for the colouring of their glazes prior to the fourteenth century two metals, and two only, for the great majority of their effects. Those two metals were iron and copper, and both continued to be used extensively in subsequent times. But other metals then came into wider use as well, notably cobalt for the well-known blue and white wares, and, later still, gold for the familiar group known as *famille rose.*

The Chinese potter first used copper on an extensive scale for colouring his glazes in the T'ang dynasty, A.D. 618–906. In that dynasty the potter produced a variety of green glazes from cupric oxide which are relatively easy to produce. In the subsequent periods, green glazes were made in profusion and in a variety of shades. While there is not much evidence of copper greens in the succeeding Sung dynasty—960–1279, or, say, from the date of the crowning of Otto I as Holy Roman Emperor to that of the signing of Magna Carta—they were made in great variety in the Ming and Manchu dynasties; that is, during 1368–1912, or from the date of Chaucer to modern times.

Cupric oxide in a glaze gives rise to a range of colour from blue to green, and these colours are accounted for by the varying amounts of cupric oxide present and especially by the nature of the glazes in which it is incorporated. The more basic the glaze, the greater will be the tendency to a blue colour; and the more acid the glaze, the greater will be the predominance of the green.

Cupric oxide dissolves in a glaze formed of potassium silicate or of sodium silicate, or a mixture of the two, to give a blue colour at about 1,300° C. If alumina is present as well, there is a considerable tendency for the blue to turn to green. If lead is present, the potash lead silicate glaze is blue, but tends to green if the lead is in excess. To retain a blue colour, the alkaline constituent must be relatively high, and if alkali is lost by volatilization, the glaze becomes acidic and green will result. But the alkali content must not be too high, since then the glaze becomes unstable and is liable to break down on exposure to a humid atmosphere.

The blue glazes from cupric oxide were not mastered until the Ming and Manchu dynasties. It was, and is, a difficult colour effect to produce. The greens from copper are relatively simple in comparison.

The fact that ceramic production in China from the Ming dynasty onwards was mainly centred in the ceramic metropolis of Ching-tê-chên, where an enormous number of operatives were employed under imperial patronage, no doubt accounts for the greater technical skill responsible for this and other glaze effects.

Under reducing conditions, copper in a glaze produces the range of reds which are familiar; the famous *sang de bœuf* and the peach-bloom glazes, as well as a variety of other shades of red, are due to copper. These copper-red glazes are brought about by the reduction of cupric oxide to the metal itself in a finely divided colloidal condition. In order to produce a clear blood-red glaze, not more than one half of one per cent of copper must be present. If more than that is put into the glaze, the colour becomes opaque, with a red sealing-wax appearance.

The chemistry of the copper-red glazes was established by Dr. J. W. Mellor and may be briefly summarized as follows. The red colour is due to the even aggregation of finely divided colloidal particles of copper to form a band in a certain portion of the glaze. The formation and maintenance of this red band are assisted by the presence of iron (or tin) oxide. The effect is brought about by a reducing atmosphere at the outset, and the glaze is finished off in an oxidizing atmosphere.

Colloidal copper, when in a very fine state of division, is yellow; in a slightly less fine state it is red, and when the particles are slightly larger still, they look blue by transmitted light.

At the outset, under strong reducing conditions, the cupric oxide is reduced, and any iron present is reduced to ferrous oxide. The atmospheric oxygen, on its introduction, attacks the molten glaze and oxidizes the topmost layer, converting the copper to cupric oxide. As a result, the surface layer of a copper-red glaze is colourless, or faintly green from the small amount of copper in the glaze. Below that layer the oxidizing action is relatively slight, and a layer of yellow can generally be seen consisting of finely divided particles of colloidal copper. Below that layer there is no oxidizing action on the part of the atmospheric oxygen, and a red band of slightly larger sized colloidal particles appears, below which is a narrower band of blue particles of slightly larger size still. The iron oxide present helps to stabilize the colloidal copper and keep it dispersed to form and maintain the red band.

The famous peach-bloom glaze is a variety of the *sang de bœuf* in which the attack of the atmospheric oxygen is allowed to continue longer. As a result, the red colour is diminished to a pinkish-red with the blue particles showing faintly below it. Sometimes in these peach-bloom glazes, which are difficult to produce in perfection, green spots appear. These green spots are due to colloidal particles of copper forming small aggregations by flocculation. These are oxidized to cupric oxide by the atmospheric oxygen and immediately dissolve in the glaze to give the characteristic green of cupric oxide.

An on-glaze copper-red glaze which is entirely different from the in-glaze effect can be produced by the formation of a copper aerosol as a thin layer of copper particles near the surface of the glaze.

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* Summary of a Wednesday Evening Discourse at the Royal Institution, delivered on May 18.

OBITUARIES

Mr. F. N. Ashcroft

IT was with deep regret that his many friends heard of the sudden death in London on April 4 of Frederick Noel Ashcroft. He had just completed a great task as honorary treasurer to the Eighteenth Session of the International Geological Congress. His careful attention to detail and his devotion to the work contributed largely to the great success of the Congress. He was publicly thanked for his work at a meeting of the Geological Society on March 23. Ashcroft brought to this task a wide knowledge of business accounts. He had been honorary treasurer of the Geological Society of London during 1929–47, and of the Mineralogical Society during 1920–42; also he was a managing trustee of the Geologists Association and of the Mineralogical Society. He was also honorary treasurer and vice-chairman of the Metropolitan District Nursing Association, with which he had been connected as a member of the Executive Committee since 1920. He was president of the Mineralogical Society during 1942–45, and at the time of his death he was its foreign secretary; he was also a vice-president of the Geological Society.

To his many friends in London, it must have seemed that Ashcroft's whole life was devoted to the financial affairs of these societies; but he was first and foremost a mineralogist, and his lasting memorial in the years to come will be the two superb collections of minerals which he had presented, or has now bequeathed, to the British Museum (Natural History), documented with an accuracy which few others would have had the patience and knowledge to achieve.

Ashcroft went from Rugby to Magdalen College, Oxford, in 1897, and gained a first in honours chemistry in 1901. He worked at Tübingen in 1901 and later at University College, London, in the Department of Organic Chemistry, and published a paper in the *Journal of the Chemical Society* in 1907. At Oxford he had also studied mineralogy under Miers, from whom, like so many others, he acquired an interest in minerals which decided the main lines of his future work. Ill-health prevented him from undertaking any full-time work; but Ashcroft could not be idle and he devoted himself to the study and collection of minerals, working partly in the Mineral Department of the British Museum and partly in the Chemistry Department of University College, London, where J. Norman Collie, himself a fair mineralogist, was professor. At first specializing in zeolites, Ashcroft brought together in the course of ten years or so a notable collection of these minerals from all over the world. In 1914 he presented the bulk of this collection to the British Museum, retaining only his Irish specimens, intending to continue publishing accounts of these when time allowed. It was well after the conclusion of peace, in 1920, that Ashcroft turned his attention to the minerals of the Swiss Alps. Here he set out not merely to acquire fine specimens, but also to record the exact localities where each was found and to collect representative specimens of all the minerals associated in each locality, thus bringing together all the data for a complete study of the distribution and paragenesis of the minerals. Carrying a heavy camera, hammers and chisels, he went round the recently worked localities with the mineral collectors on his annual visit to Switzerland, collecting, noting and photographing. He was an expert photographer and his catalogue is profusely illustrated by photographs of his own taking. Many of these were used to illustrate "Die Mineralien der Schweizeralpen" by Niggli, Koenigsberger and Parker, with whom Ashcroft collaborated. Others appear as plates in Arthur Holmes's "Principles of Physical Geology".

It was an education to accompany Ashcroft on one of these visits to the Alps and to see him at work. He had gained the affection of mineralogists and mineral collectors all over Switzerland, and if they were sorry to see their best specimens being taken to London year after year, they forgave him for the big kind-hearted enthusiast that he was. His collecting trips were usually followed by a holiday with his family. He had married in 1904 Constance Muriel, daughter of J. C. Im Thurn, and had two sons and two daughters. He was devoted to his family and very proud of his grandsons, and they were all devoted to him.

He had many friends among mineralogists at home and abroad. He was a member of the Swiss Mineralogical Society and of the Museums Association as well as of the other societies mentioned, and he was a charter member of the Mineralogical Society of America. W. CAMPBELL SMITH

Mr. Edward Heawood

MR. EDWARD HEAWOOD, emeritus librarian of the Royal Geographical Society, died on April 30, in his eighty-fifth year.

Heawood was attracted to geography through an early interest in natural history, and the great narratives of exploration. After taking his degree in classics at Cambridge, he received instruction in surveying and other field studies at the Royal Geographical Society, and spent two years in India working on a settlement scheme among the Santals in the Bengal Duars. On his return, he joined the staff of the Society, assisting with the newly established *Geographical Journal* and in the library. On the retirement of Dr. H. R. Mill in 1901, he succeeded him as librarian, an appointment which he held until 1934. During these years the Society's Library expanded considerably under his guidance, particularly in its collections of foreign geographical periodicals and of early geographical texts and atlases. His extensive knowledge of the literature of geography, aided by an exceptional memory, was readily placed at the disposal of students.

His special interest was at first in African geography and in the history of exploration generally. His "History of Geographical Discovery in the 17th and 18th Centuries", published in 1912, is a careful and comprehensive study which remains the best general guide to that period. This line of study led naturally to that of the cartographic sources, to which his attention was increasingly given, until he had established a widely recognized reputation as an authority. Most of his work is to be found in the *Geographical Journal*, in numerous notes and reviews as well as in longer papers, but two important memoirs appeared as separate publications of the Royal Geographical Society: "The Map of the World on Mercator's Projection by Jodocus Hondius, 1608" (1927) and "English County Maps in the Collection of the R.G.S." (1932). A further development of this work, which was perhaps his most individual contribution, was his extensive study of water-marks used by paper-makers, which threw much light on the sources and distribution of paper, in addition to its use in dating maps and other documents. He concentrated upon marks on paper used in England, filling in the gap left by Briquet and other Continental writers. His first article, in the *Geographical Journal* of May 1924, was followed by others in *The Library* of 1930, 1931 and 1948. On the day of his death he had been at work on an index to a selection of his tracings of marks, which is to be published in Holland.

Heawood received the Research Medal of the Royal Scottish Geographical Society in 1933, and in the following year the Victoria Medal of the Royal Geographical Society. For many years he was treasurer of the Hakluyt Society, and had been recorder of Section E (Geography) of the British Association. G. R. CRONE

Prof. J. Velenovský

The death occurred on May 7 of the Czechoslovak botanist, Prof. Josef Velenovský, at Mnichovice, near Prague; he was ninety-one years of age.

Born at Čekanice, a small southern Bohemian village, on April 22, 1858, Velenovský was a student of Sachs and Čelakovský, and in 1885 he obtained a post at the Charles University of Prague. In 1898 he succeeded Čelakovský as professor and continued teaching for forty-two years until he retired in 1927. It was during his professorship that the present Botanical Institute was erected, and for many years Velenovský was also director of the botanical gardens attached to the Institute.

During his career he wrote at least four hundred different publications, including a number of textbooks and treatises that served successive generations of Czech students. His early researches related to phytopalæontology, especially the fossil flowering plants occurring in Bohemian chalk (1882–87). His studies in this field were published in a work of five volumes, "Flora Cretacea Bohemiæ".

Later, Velenovský made a detailed systematic study of fungi, and he is probably best known in Great Britain for his "České Houby" (Bohemian Fungi), first published between 1922 and 1926 and revised in 1946. The book is noteworthy for its illustrations. He spent many vacations in the Balkans, and one outcome was his "Flora Bulgarica" (1891), the standard flora for the country and which he afterwards brought up to date with addenda. Later work was mainly concerned with studies of the bryophytes (1897), though he contributed to many branches of systematic botany, and as late as 1947 he was engaged upon "Novitates Mycologicæ Novissimæ", which is being published by the Czechoslovak Botanical Society.

After retiring, Velenovský maintained his scientific interests and also wrote some philosophical and historical essays. One of these was for the jubilee publication in 1932 of the Czech Naturalists' Club, of which he was the oldest living member. Velenovský received many Continental and some British honours.

J. G. F. D.

NEWS and VIEWS

Plant Pathology Laboratory: Mr. W. C. Moore

Mr. W. C. Moore has been appointed to the post of director of the Plant Pathology Laboratory of the Ministry of Agriculture and Fisheries at Harpenden, on the retirement of Mr. C. T. Gimingham. Mr. Moore received his early education at Sexey's School, Bruton, whence he joined Trinity College, Cambridge, in 1919, becoming a major scholar in 1921. After graduation he remained at the Cambridge Botany School to participate in the investigations on silver-leaf disease of fruit trees then in progress. He joined the staff of the Plant Pathology Laboratory in 1925 as assistant in mycology, becoming mycologist in 1944 and deputy director in 1948. During his official career he has been in the closest touch with other British plant pathologists, especially those in the advisory services, whose work he has greatly fostered and assisted. Not infrequently he has suggested problems for investigation. Latterly, he has been responsible for editing a series of valuable reports on the incidence of plant diseases in England and Wales. He has taken a principal part in preparing the excellent leaflets on the diseases of economic plants issued by the Ministry. Notwithstanding heavy administrative duties he has continued his own researches (chiefly on little-known diseases), the results of which have been mostly published in the *Transactions of the British Mycological Society*. Noteworthy, too, is his bulletin on the "Diseases of Bulbs", published in 1939, which is an important contribution to plant pathological literature. He was president of the British Mycological Society in 1941 and of the Association of Applied Biologists in 1947–48. Mr. Moore is a keen gardener, and the practice of this art has been not without influence on his career as a plant pathologist.

Geology at Sheffield: Prof. Leslie R. Moore

Dr. Leslie R. Moore, at present reader in stratigraphy in the University of Bristol, has been appointed to the Sorby chair of geology in the University of Sheffield, in succession to Prof. F. W. Shotton (see *Nature*, 155, 664; 1945), who has been appointed to the chair of geology at Birmingham. It is expected that Prof. Moore will take up his duties at the opening of the new session in October next. After taking his first degree at the University of Bristol in 1934, Dr. Moore carried out postgraduate work on "The Sequence and Structure of the Somerset and Gloucestershire Coalfields", for which he was awarded the Ph.D. degree. His first university appointment was in the Department of Geology, University College, Cardiff; later he became research fellow and lecturer in geology in the University of Glasgow, before returning to Bristol as reader in stratigraphy. Dr. Moore's researches have dealt especially with the geology of coal measures and oil shales and are notable for the employment of new techniques, to the development of which he himself has made substantial contributions.

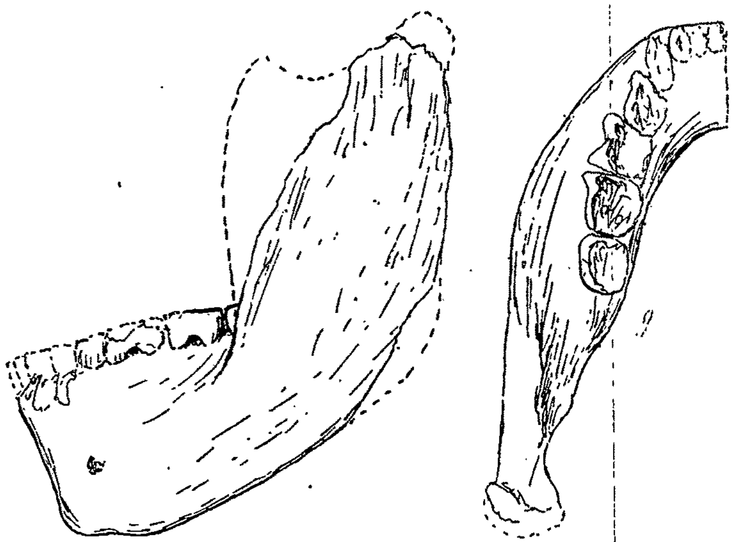
New Grassland Research Station at Hurley: Dr. W. Davies

Dr. William Davies, at present director of the Grassland Improvement Station of the Ministry of Agriculture and Fisheries at Drayton, Stratford-on-Avon, has been appointed director of the Grassland Research Station for Great Britain. This new station is being established at Hurley in Berkshire and is being amalgamated with the Drayton Station under the new Governing Body, the formation of which was recently announced. Dr. Davies was a student at the University College, Aberystwyth, under Sir George Stapledon, and was later a member of staff at the Welsh Plant Breeding Station at Aberystwyth. On the establishment of the Grassland Improvement Station, he was appointed assistant director, and became director in 1946 on the resignation of Sir George Stapledon. Dr. Davies has conducted researches and surveys in New Zealand, Australia and the Argentine. A survey of the grasslands of England was made in the years 1938–40, and the results were published in 1941. More recently, Dr. Davies has visited several African countries and carried out grassland surveys there.

Jaw of the Ape-Man *Paranthropus crassidens*

Dr. Robert Broom, of the Transvaal Museum, Pretoria, who is now on a visit to Great Britain, during which he has received the Wollaston Medal of the Geological Society of London awarded to him this year, writes as follows:

"In November 1948, we found at Swartkrans while excavating a new site in co-operation with the California University Expedition a lower jaw with very large molar teeth. I called it *Paranthropus crassidens*. Not only did we find the imperfect jaw of a young male with three upper teeth, but also some months later the snout of what appeared to be a female. The upper incisors and canine are typically human. Last month, while I was in America, my assistant, Mr. John T. Robinson, discovered an almost complete huge jaw with most of the teeth. I have, of course, not yet seen the specimen, but the accompanying drawings were made from photographs taken by Mr. Robinson. The jaw is really enormous—very considerably larger than that of Heidelberg man. The molar teeth are very large, but the canines and incisors remarkably small. Another remarkable feature about the jaw is that it has a rudiment of a chin. The ascending ramus is very high and large. Mr. Robinson has also got a part of the face with the nearly complete palate. This shows that the face is almost orthognathous. We must, I think, conclude that the brain was very large. It seems improbable that the brain can have been less than 800 c.c., and very likely it may have been more than 900 c.c. Mr. Robinson has just written me that he has part of a mandible with one molar tooth that looks remarkably human. While I can express no definite opinion until I see the specimen, it may be that the jaw is that of a small female of the same species as the large jaw."



Paranthropus crassidens Broom. Side-view and occlused view of left mandible. ½ natural size

British Gelatine and Glue Research Association

Mr. A. G. Ward has been appointed director of the newly formed British Gelatine and Glue Research Association. Mr. Ward's main interests have been in colloid science; in particular, the relation of colloidal structure to mechanical properties. During the War he was engaged on research on the mechanical and physical properties of propellants and plastics, together with studies on nitrocellulose, for the Ministry of Supply. This work included the use of X-ray diffraction technique to follow the changes in nitrocellulose structure in cordite manufacture. In 1946 he joined the Building Research Station of the Department of Scientific and Industrial Research to set up a Rheology Section for building materials, and he has since then published several papers on the rheology of pastes as well as two books on crystals and colloids.

Although the gelatine and glue industry is relatively small, its products are essential in many industries connected with food, photography, pharmacy and many household articles, and its by-products are fertilizers and fats. The industry has been founded on cheap raw materials such as hide waste and bones, and little change has taken place in traditional methods. Of late, production has expanded to meet all home needs and to capture export markets; but increased technical efficiency and new ideas are greatly needed if this activity is to be maintained. It was decided, therefore, in 1947 to form a Research Association. Preliminary work was done by the Federation of Gelatine and Glue Manufacturers, and already more than half the member firms have joined. The Research Association will work along the normal co-operative lines and will be assisted by a grant from the Department of Scientific and Industrial Research. Since the industry is not centred on any particular locality of Great Britain, the research laboratories will be set up in London. Work will be done in two main fields: fundamental research on raw materials and problems affecting the industry; and research with immediate practical application, including the possibility of new uses.

Italian National Awards: Einaudi Prizes

Through the generosity of Signor Luigi Einaudi, President of the Italian Republic, the Lincei Academy at Rome is to award four national prizes of a million lire each, at the end of every year of his term of office. The names of the first prize-winners have just been announced, as follows: General Prize (Mathematical and Natural Sciences): Prof. O. M. Olivo, of the University of Bologna, for researches in bio-electric phenomena of the cardiac cell; Prize for Physics: Prof. G. P. S. Occhialini, of the University of Brussels, for researches in nuclear physics and in particular for his work on the discovery of the heavy meson; General Prize (Moral Sciences): Prof. R. Mondolfo, of Bologna, for work on the history of philosophy; Prize for Archæology: Prof. C. Anti, of the University of Padua, for researches on ancient Greek theatres.

Science Service, Washington

At the recent annual general meeting of Science Service, Dr. L. A. Maynard, professor of nutrition and biochemistry of Cornell University, and Dr. Rene J. Dubos, bacteriologist and member of the Rockefeller Institute for Medical Research, New York City, were elected new trustees, being nominated by the National Academy of Sciences and the National Research Council, respectively. At the same time, the following officers were re-elected: *President*, Dr. Harlow Shapley, director of Harvard College Observatory; *Vice-President and Chairman of the Executive Committee*, Dr. Alexander Wetmore, secretary of the Smithsonian Institution; *Treasurer*, O. W. Riegel, director of Lee School of Journalism, Washington and Lee University; *Secretary*, Watson Davis, director of Science Service. Additional members elected to the Executive Committee were Frank R. Ford, editor, Evansville Press, Evansville, Ind., and Dr. Karl Lark-Horovitz, Purdue University. Science Service is an endowed, non-profit-making institution for the popularization of science. The board of trustees consists of three representatives each from the American Association for the Advancement of Science, the National Academy of Sciences, the National Research Council, the journalistic profession, and the Scripps Estate. The address of Science Service is 1719 N St., N.W., Washington 6, D.C.

An Unusual Solar Halo

MR. J. E. BOWMAN, Armament Research Establishment, Fort Halstead, Kent, writes: "On May 10 at Shoeburyness I observed a solar halo of an unusual size. For about the last hour before sunset a well-defined parhelion of the 22° halo was visible to the north of the sun; but there was no trace of the 22° halo itself. Just after the sun had set, however, the upper part of the 22° halo appeared, accompanied by a much smaller halo, the radius of which I estimated to be about 8–9°, and a sun pillar extending to some 15° above the sun. A patch of relatively greater brightness appeared where the sun pillar intersected the 8° halo. The whole spectacle, which lasted until a quarter of an hour after sunset, was extremely faint and could be distinguished only with difficulty. The display of halo phenomena continued after dark, for at 10 p.m. the moon was accompanied by the two paraselenæ of the 22° halo. Again, however, there was no trace of the 22° halo itself."

Co-operation between Universities and Technical Colleges

IN his address to a recent meeting of the Yorkshire Council for Further Education, Sir Ronald Weeks, chairman of the National Advisory Council for Education in Industry and Commerce, discussed the need for much closer co-operation between universities and technical colleges (*Tech. J.*, 41, No. 4; April 1949). Considering the place of the graduate in industry, Sir Ronald said that more attention should be given to the possibility of strengthening the science graduate on the technological side, and the Higher National Certificate student on the science side. Arrangements should also be made whereby graduate students could attend special courses of technology at the technical college either by block release or part-time study. Sir Ronald Weeks suggested certain principles for the provision of arrangements of this kind which must be observed. Among these are the following: both universities and technical colleges must be considered available for meeting the needs, having regard to their present facilities or possible future facilities; the convenience and needs of the students must come first, particularly in the case of part-time students; technical colleges must not be regarded as the poor relations of the universities, as this is fatal to co-operation and good understanding; there must be an easy means of transfer of students from universities to technical colleges, and vice versa.

Earthquakes during March

AT least eleven strong earthquakes occurred in the world during March. The greatest, and also the deepest, happened on March 4 from a focus having an epicentre near lat. 36·5° N., long. 70·5° E., in the Hindu Kush, Afghanistan. The depth of focus was probably rather greater than 200 km. and the strength 7½ on the instrumental scale. Owing to its strength and depth, the shock was felt over a wide area in Afghanistan and the North-West Frontier Province, Pakistan, and although the full extent of the damage is not yet assessed, the earthquake is known to have damaged the Roman Catholic cathedral in Lahore. The next most intense (scale *c.* 7) was probably that occurring on March 27 from a focus having an epicentre in the Celebes Sea off the southern coast of Cape Mindanoa. Strong shocks on March 16 and 17 had their epicentres in the region of the Bismarck Archipelago. On March 9 an earthquake with strength 5½ and epicentre near lat. 37·1° S., long. 121·3° W., in central California set off burglar alarms and rolled stones off Telegraph Hill, San Francisco, but did no serious damage. At Hollister some windows and plaster were cracked, and small objects were shaken off shelves. Of the small shocks during the month, three may be mentioned. On March 7 an earthquake was felt with strength 3–4 on the Modified Mercalli scale in the south-west Alps near Messtetten. It had a depth of focus, according to Dr. W. Hiller, of Stuttgart, of less than 5 km. On March 11 a strong tremor shook the area around Dalton, New South Wales, Australia, and cracked buildings there, causing damage estimated at £2,000. The shock was felt in Sydney and Canberra. On March 22 an earthquake was felt in the Département des Basses-Alpes, France, doing some damage at Lauzet. Instrumental readings for the month have been received from the central stations of the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association; the Central Seismological Bureau at Strasbourg; and individual observatories at De Bilt (Netherlands), Durham, Stuttgart and Toledo.

Tellus: A New Journal of Geophysics

THE Second World War has brought losses and also gains in the periodical literature of geophysics. Among the gains is *Tellus*, a quarterly journal of geophysics issued by the Swedish Geophysical Society. Vol. 1, No. 1, February 1949, consists of 64 pages, and is obtainable from the Department of Meteorology, University of Stockholm, price 2 U.S. dollars. The Society was founded in 1920 to promote research and international collaboration in geophysics; but the institution of a regular journal is a new departure made possible by a Government grant and by the co-operation of the Lithographic Institution of the General Staff. Contributions, to be printed in English, French or German, are invited on all branches of geophysics, from all countries. The first issue, however, is practically an all-Swedish one, the authors concerned being Pettersson, Rydbeck and Stranz, Palmén, Bergeron, Nyberg, Rossby, Ahlmann, and Ångström. Five of the contributions are meteorological; one is ionospheric, being on the effects of solar flares; and two relate to marine expeditions, one prospective and the other that of the *Albatross*, to obtain sediment cores to study the geochronology of the deep ocean bed.

Institution of Mining and Metallurgy

The second Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy will be given by Dr. C. H. Desch, who will speak on "The Effect of Impurities on the Properties of Metals". The Lecture will be delivered at the Royal Institution, 21 Albemarle Street, London, W.1, on July 6, at 5 p.m., and admission is free and without ticket.

The Institution will be holding a symposium on "The Refining of Non-Ferrous Metals" during July 7–8 at the Royal Institution of Chartered Surveyors, 14 Great George Street, Westminster, London, S.W.1. Tickets of admission (which are free) and further information may be obtained from the Secretary, Institution of Mining and Metallurgy, Salisbury House, Finsbury Circus, London, E.C.2.

Canadian Scholarship Awards

Scholarships have been granted by the National Research Council of Canada to 165 graduates to enable them to pursue postgraduate studies during the academic year 1949–50. There are nineteen fellowships at 900 dollars, sixty-four studentships at 750 dollars and seventy-eight bursaries at 450 dollars tenable at Canadian universities, and four special scholarships at 750 dollars awarded for study outside Canada. The nominal value of all scholarships for the year is 103,200 dollars as compared with the total for last year of 148 scholarships worth 97,050 dollars. Physics is represented by 65, and chemistry, in its several branches, by 59. The remainder are distributed in the other sciences as follows: bacteriology, 1; biology, 4; communications engineering, 1; cytogenetics, 1; electrical engineering, 2; geology, 3; histology, 2; mathematics, 3; medical research, 2; microwave studies, 1; metallurgy, 2; mineralogy, 2; nutrition, 1; physical metallurgy, 2; physiology, 1; radiation studies, 2; spectroscopy, 3; zoology, 8.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have been announced: G. Swaine, entomologist, Tanganyika; R. L. Woolridge, veterinary officer, Kenya; E. Pawson, agricultural chemist, Northern Rhodesia; K. L. Richards, livestock officer, Agricultural Department, Cyprus; A. J. Whitaker, electrical engineer, Nigeria; J. L. King (deputy electrical engineer-in-chief, Nigeria), electrical engineer-in-chief, Nigeria; J. M. Stock (senior electrical engineer, Nigeria), deputy electrical engineer-in-chief, Nigeria; J. R. Lockie (conservator of forests, Nigeria), assistant chief conservator of forests, Nigeria; R. Smeathers (assistant conservator of forests, Trinidad), deputy conservator of forests, Trinidad; J. H. Bowen (senior inspector of plants and produce, Gold Coast), chief inspector of plants and produce, Gold Coast; A. H. Fetherstonhaugh (control officer, Game Department, Federation of Malaya), chief game warden, Federation of Malaya; T. P. Lecky (agricultural officer, grade 2, Jamaica), senior livestock officer, Jamaica; W. G. Stuart (agricultural officer, grade 2, Jamaica), agricultural officer, grade 1, Jamaica; C. Teesdale (entomological field officer, Kenya), entomologist, Kenya.

Telecommunications at the Imperial College

Standard Telephones and Cables, Ltd., have endowed a readership, to be known as the Henry Mark Pease readership in telecommunications, in the City and Guilds College of the Imperial College of Science and Technology, London. Henry Mark Pease, one of the pioneers of the telephone industry in Britain, who died in March 1947, was managing director of Standard Telephones and Cables, Ltd., until 1928; he took an active part in forming the British Broadcasting Company, of which he was one of the original directors. Mr. E. C. Cherry has been appointed to the new readership. Mr. Cherry was attached to the Telecommunication Research Establishment of the Ministry of Aircraft Production during the war period and is known particularly for his contributions to the subject of electric circuit analysis.

The British Society for International Understanding

Sir Arthur Hall has been elected chairman of the British Society for International Understanding in succession to Mr. G. M. Young, the historian and literary critic, who has retired after holding the chairmanship since the Society's incorporation ten years ago. Sir Arthur Hall is director of studies at the Royal Naval College, Greenwich, and is also chairman of the English Association. Mr. Young remains chairman of the Editorial Committee of the Society's publication, *The British Survey*. Mr. Oliver Bell has been succeeded as vice-chairman of the Society by Colonel John Grace, of British Columbia, formerly director of education of the Canadian Army in Britain during the War.

Linnean Society of London: Officers for 1949

The following have been elected officers of the Linnean Society of London for the session 1949–50: *President*, Prof. F. E. Fritsch; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. B. Barnes (botany) and Dr. A. Tindell Hopwood (zoology); *New Members of Council*, Prof. A. J. E. Cave, Dr. E. B. Ford, C. C. Hentschel and Dr. C. F. A. Pantin.

Announcements

Mr. Geoffrey Munday, of the South-West Essex Technical College, who has been carrying out research on the temperature variation of the optical properties of gold, has been appointed a research-associate at the Massachusetts Institute of Technology.

A Summer School in X-Ray Analysis, somewhat similar to those held in Manchester and Cambridge in previous years, is to be held in Leeds during the period August 29–September 10. Further information can be obtained from Prof. E. G. Cox, Department of Inorganic and Physical Chemistry, University, Leeds 2.

The French Association for the Advancement of Sciences will hold its sixty-eighth annual congress at Clermont-Ferrand, during July 15–21.

Erratum. In a footnote to the communication entitled "Inelastic Scattering of Protons by Magnesium and Aluminium" in *Nature* of May 28, p. 848, the present address of the author, E. H. Rhoderick, is wrongly stated; it should be Department of Natural Philosophy, University of Glasgow.

LETTERS TO THE EDITORS

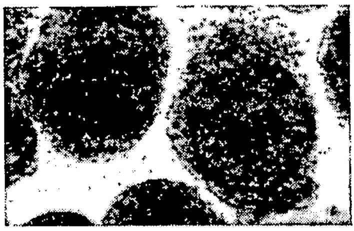
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption of Ultra-violet Light by Living Cells

NUCLEIC acids, because of the presence of purines and pyrimidines in the molecule, absorb ultra-violet light with a maximum absorption at 2600 A. Recently, Larionow and Brumberg[1] suggested, on the basis of ultra-violet light photomicrographic studies, that desoxyribonucleic acid, as it exists in the nuclei of living cells, does not absorb ultra-violet light of wave-lengths near 2600 A. These investigators contended that absorption develops as a result of injury or death of the cell.

Ultra-violet light photomicrographs of living cells made in this laboratory show absorption of light of wave-length 2654 A. Cells of the Walker Carcinoma No. 256 of the rat were used. Cell suspensions were prepared immediately after removal of tumours from the host by mincing tissue finely with scissors in Ringer's solution and straining through a thin layer of cotton to remove coarse aggregates. Cells prepared in this manner and kept for much longer periods of time than was required in these experiments produced tumours when implanted into rats. The cells, in Ringer's solution, were placed on a quartz slide and covered with a quartz coverglass and sealed with paraffin.

Ultra-violet light photomicrographs were made with a quartz optical system microscope by the method previously described[2], with a 2·5-mm. objective, N.A. 0·85 and a 10 × ocular, magnification 240 ×. Condenser diaphragms were closed to small aperture.



Ultra-violet light (2654 A.) photomicrograph of Walker Carcinoma No. 256 of the rat, magnification × 900

Focusing was performed by means of a fluorescent screen and a magnifier with 2654 A. light. The focus was obtained on one area of the field; all light was then barred from the microscope, and the slide was moved to a distant field. In this procedure the cells were exposed to only the amount of ultra-violet light necessary to produce the image on the film. Panatomic X (Eastman Kodak Co.) was used. Photomicrographs made in this manner (see illustration) show the same absorption pattern as those made after the cells have been exposed to several times the amount of ultra-violet light necessary for photomicrographs.

Nuclear and cytoplasmic absorption varied considerably from cell to cell, depending on the metabolic state. Chromosomes, where present, absorbed intensely. In the resting cells the nucleolus usually absorbed much more intensely than did the remainder of the nucleus.

Visual observations of fluorescent images of cel illuminated by ultra-violet light made by rapidl moving the slide across the microscopic field reveal absorption by cells as they came into view; unde these conditions exposure to ultra-violet light wa less than one second. Chicken erythrocytes in whol blood when observed in this manner within three t five minutes after drawing the blood showed intens nuclear absorption. These observations, which hav been repeated many times, indicate that the nuclei acids as they exist in the living cells absorb ultra violet light. This contention is supported by th work of Wyckoff[3], who made successive ultra-viole (2750 A.) photographs of a living grasshopper sperm atocyte and showed absorption by the chromosome throughout division.

J. O. ELY
M. H. ROSS

Biochemical Research Foundation,
Newark, Delaware.
Dec. 22.

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[1] Larionow, L. T., and Brumberg, E. M., *Nature*, **158**, 663 (1946).

[2] Ely, J. O., and Ross, M. H., *J. Franklin Inst.*, **246**, 87 (1948).

[3] Wyckoff, R. W. G., "Symposia on Quantitative Biology", **2**, 3 (1934).

Plant Injury from Phosphorus-32

IT has been generally considered, on the basis o the work reported by Hendricks and Dean[1], that sufficient margin of safety exists in the tolerance o the plant to radioactivity to permit the use o phosphorus-32 as a tracer in phosphate experiment without fear of any effects on plant growth from th radioactive isotope. The recent communication b Scott Russell and Martin[2], indicating an injuriou effect, suggests that a danger exists which require further study.

In the course of field experiments with wheat i Saskatchewan in 1948, phosphorus-32 was used t follow the uptake of phosphate from seven differen fertilizer treatments. Only one row (9 ft. long) i each treatment plot was treated with radioactiv fertilizer; but the two immediately adjacent row were treated with exactly the same amount of th same inactive fertilizer. While this was done t avoid handling large amounts of tracer, and also t check the amount of fertilizer applied with the seed in one row taken up by adjacent rows, the arrangement was ideal for an estimation of effects due t phosphorus-32.

Fertilizer was applied to give P_2O_5 applications of 12, 24 and 48 lb. of P_2O_5 per acre. Two dilutions of phosphorus-32 were used, one at 26 microcuries and the other at 260 microcuries per gram of phosphorus (both measured at time of planting), in connexion with harvests at four different stages of growth. We therefore have information on identical fertilizer treatments, with and without phosphorus-32, at various stages of growth, and at two levels of phosphorus-32 activity. The application of P_2O_5 at 48 lb./acre is the treatment most likely to show injury, since the absolute uptake of phosphorus-32 was highest for this treatment.

Measurements of yield, total phosphorus and phosphorus-32 were made as in previous work[3]. The data are presented below.

Some of the data indicate a small but statistically significant increase as a result of the presence of phosphorus-32. This requires a word of explanation.

(*a*) Plants harvested at 2–3 weeks; P^{32} applied at 26 μc./gm. P^{31} at time of planting

Phosphate treatment	lb. P_2O_5 per acre	Location *B*			Location *H*		
		% of applied P taken up	Plant wt. (gm./6 ft. row) Active rows	Inactive rows	% of applied P taken up	Plant wt. (gm./6 ft. row) Active rows	Inactive rows
A	12	7·2*	10·9*	10·0	6·5	13·9	10·2
A	24	4·0	10·7	10·8	4·5	16·1	14·6
A	48	3·1	12·3	11·0	3·0	13·7	8·2
B	24	2·9	10·5	10·6	3·8	14·4	11·6
C	24	2·0	9·6	9·8	3·1	14·1	12·4
D	24	0·9	7·6	6·9	0·8	10·7	11·3
E	24	0·5	8·3	7·9	1·1	12·9	10·0
Mean			10·0	9·6		13·7	11·6
L.S.D. 5% pt.			0·8			1·9	

Mean of all treatments, first harvest: active rows, 11·8; inactive rows, 10·4; L.S.D. 5% pt., 1·0
A, $NH_4H_2PO_4$; *B*, NaH_2PO_4; *C*, $CaH_4(PO_4)_2$; *D*, $Ca_2H_2(PO_4)_2$; *E*, $Ca_2H_2(PO_4)_2 + Ca(NO_3)_2$

(*b*) Plants harvested at various stages: treatment *A*, 48 lb. P_2O_5/acre

Stage	Age in weeks	Activity at planting (μc./gm. P^{31})	Location *B*			Location *H*		
			% of applied P taken up	Plant wt. (gm./6 ft. row) Active rows	Inactive rows	% of applied P taken up	Plant wt. (gm./6 ft. row) Active rows	Inactive rows
Shot blade	2–3	26	3·1*	12·3*	11·0	3·0	13·7	8·2
Heading	5½	26	17·9	69·4	72·5	12·3	72·1	71·2
Soft dough	7½	26	21·1	143·4	139·5	12·4	97·4	86·3
Maturity	11½–12	260	25·0	189·9	189·2	13·6	123·2	124·6
Mean				103·7	103·0		76·6	72·6
L.S.D. 5% pt.				12·0			8·8	

Mean of both locations, all dates: active rows, 90·2; inactive rows, 87·8; L.S.D. 5% pt., 9·6
* These figures are means of four plots. Statistical analysis was by Student's Pairing Method, using the individual figures, rather than means

A little bias at the first harvest at Location *H* resulted from uneven germination. In the original 9-ft. row, 3 ft. were chosen for harvest, taking 6 ft. also from the non-active rows alongside. The active row, which was of greatest interest, was taken to give the most uniform continuous 6 ft. of growth, but occasionally this meant that gaps occurred in the adjacent rows for that particular plot. We do not consider that any real benefit results from the use of phosphorus-32.

The results indicate no signs of harmful effects from phosphorus-32 as used in this experiment. This would confirm Hendricks's and Dean's original conclusion that there is sufficient tolerance to make the avoidance of injury from phosphorus-32 a relatively easy matter, at least for field experiments.

G. Dion
C. F. Bedford
R. J. St. Arnaud
J. W. T. Spinks
Departments of Soils and of Chemistry,
University of Saskatchewan,
Saskatoon.

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[1] Hendricks, S. B., and Dean, L. A., Auburn Conference on Use of Radioactive Isotopes, 76 (Edwards Brothers, 1948).

[2] Scott Russell, R., and Martin, R. P., *Nature*, 163, 71 (1949).

[3] Spinks, J. W. T., Dion, G., Reade, M., and Dehm, J. E., *Sci. Agr.*, 28, 309 (1948).

Cold Hardiness and Seed Shape in Maize

At least one mid-Western seed company has asserted that 'round-grade' dent corn (maize) seeds withstand more than 'flat-grade' seeds the cold weather after early spring sowings.

Fifty seeds of both kinds of six single-cross and one double-cross hybrids were used to test this. These were kindly supplied by Mr. H. Everett. Seeds were placed in seed-boxes containing soil and lightly covered with it. Two rows of round seed were followed by two rows of the corresponding flat seeds of each hybrid, approximately twenty-five seeds per row. Treatment was by the method of Haskell[1]. The seed-boxes were placed in a 50° F. room and watered when necessary. After eight days they were removed to a warm greenhouse. Maximum germinations were recorded.

Behaviour of round and flat dent corn seed subjected to 50° F. for 8 days

Pedigree	Round			Flat		
	Av. wt. of 10 seeds	% germ.	Angular germ.	Av. wt. of 10 seeds	% germ.	Angular germ.
	(gm.)			(gm.)		
267 × 263·5	4·37	92	73·6	3·58	98	81·9
274 × 263·5	4·68	86	68·0	3·83	88	69·7
251 × 450·6	3·74	100	90·0	3·12	90	71·6
277 × 275	3·73	64	53·1	3·05	80	63·4
268 × 263·5	4·03	84	66·4	3·59	78	62·0
284 × 283	3·92	44	41·6	3·37	50	45·0
Conn 520	—	8	16·4	—	28	31·9
		Mean	58·4		Mean	60·8

The accompanying table gives the values in percentages and angles; the average weight of ten seeds of each type is also given. Germinations of round and flat seeds are very similar, even though round ones are somewhat heavier than flat seeds. An analysis of variance was made on the angular values. χ^2 values were obtained by dividing the sum of squares by the theoretical variance, given by 820·7/50. Each χ^2 had a significantly low probability, especially that for error, or variation within the series. Therefore, using the error mean square, values of *t* were also obtained.

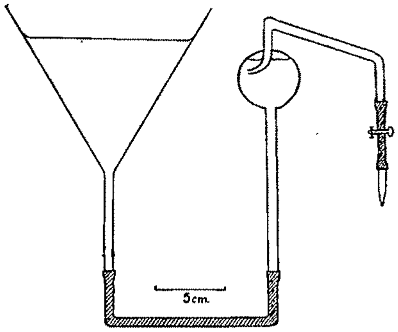
For flat and round seeds, $t_{[6]} = 0·55$, which is not significant. Variation between strains gives *V.R.* = 12·9, which has a probability *P* of < 0·01, suggesting differential behaviour between the hybrids. However, in view of the high value of χ^2 for the error item, it would seem that there is an indirect effect due to the round/flat condition which may be due to some linked quality associated with this difference, rather than to an immediate effect.

GORDON HASKELL
John Innes Horticultural Institution,
Merton Park, S.W.19.
Dec. 3.

[1] Haskell, G., *Science*, 147, 150 (1948).

Continuous Sedimentation for the Concentration of Trematode Eggs in Fæcal Suspensions

METHODS of concentration for helminth eggs, such as centrifuging with sodium chloride or zinc sulphate solutions and looping off the surface, or the Gordon – Whitlock egg-counting technique for nematode eggs in sheep fæces, cannot successfully be used for trematode eggs because these collapse in hypertonic solutions owing to their thin shells. The use of chemicals and even the mere act of centrifuging may damage the eggs and render subsequent culture unsuccessful. Multiple sedimentation of fæcal suspensions is laborious and time-consuming. The apparatus shown in the sketch will wash away the colouring matter and reduce the fæcal debris to less than half with the loss of only very few eggs. The resulting suspension is of a consistency which will greatly facilitate other operations, such as dilution egg-counts and straining through bolting silk.



This apparatus has been used successfully with sheep fæces for the concentration of trematode eggs. The apparatus is filled with water, except for the air lock in the bowl of the 'distillation splash head', and a suspension of the fæces in water, after having been passed through a 40-mesh per inch sieve, is placed in the funnel. The spring clip is released and the fæcal suspension siphons over; the heavier particles and eggs settle in the bowl. When the operation is almost completed, the funnel is washed round with a few c.c. of water. Recovery of the eggs is easily effected by disconnecting the tubing from the funnel and running the suspension, after agitation, from the splash head into a vessel.

With 6 gm. of fæces in 200 c.c. water and using a splash head with bowl of 4·5-mm. diameter, an escape jet which passes 30 c.c. of water in 1 min. was found to be the most successful. The rate of flow can be adjusted by using different escape jets, and may conveniently be graded according to the number of c.c. which pass per minute.

Examples of egg recovery using 6 gm. of fæces from sheep infected with trematodes

Trematode	No. of c.c. per min. passed by jet	Eggs recovered	Eggs lost
Fosciola hepatica	30	541	6
		252	16
		85	7
		723	11
		647	30
	40	229	16
Paramphistomum cervi	30	66	Nil
		87	Nil
	40	106	4

This apparatus may possibly be of use for other suspensions of eggs in water. It has not proved satisfactory, however, for strongyle eggs; the specific gravity in this case is too near that of water.

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Effect of Young Grass in the Diet on the Onset of Sexual Maturity in Mice

THE superior nutritive qualities of spring grass as compared with the autumn growth or aftermath, etc., have been attributed to a better and more varied supply of basic nutrients (for example, amino-acids) in the former[1]. While there is undoubtedly some truth in this, it has been slowly realized that the phenomenon may be more complex, and that there are factors in young grass which influence the endocrine system in such a way as to have a direct bearing on productivity (growth, meat and milk) as well as on reproduction (œstrous cycle)[2].

We wish to report some preliminary work (spring, 1947) on laboratory animals which may have a bearing on these problems. Young female mice were placed, immediately after weaning, in three groups on the following diets: (1) Basal diet (B.D.H. light white casein 20 parts, sucrose 60 parts, arachis oil 15 parts, B.D.H. salt mixture 3 parts and dried yeast 10 parts). (2) Basal diet with a supplement (*ad lib.*) of fresh grass cuttings. (3) Basal diet supplemented with dried grass.

All the animals were dosed with tocopherol and radiostoleum. There were twelve mice in each group, and their growth curves and the onset of maturity, as indicated by the opening of the vagina, were noted.

Group	Mean age (days) at vaginal opening	Average weight (gm.) at start of experiment	Average weight (gm.) 45 days old
1. Basal	51 ± 3·7	9·1	19·9
2. Basal and fresh grass	41 ± 4·0	10·1	20·5
3. Basal and dried grass	43 ± 5·0	9·4	19·7

The growth curves in the three groups did not differ appreciably; but the onset of sexual maturity was markedly hastened in the mice receiving a supplement of grass in their diet.

Folley *et al.*[3] have given evidence of the presence of œstrogenic substances in grass by the injection of certain extracts into immature mice. It seems from our preliminary work that laboratory animals such as mice, by natural feeding on a diet in which young grass has been included, do respond as if they were getting a continual small supply of 'œstrogenic substances' from the diet. Bennetts *et al.*[4] demonstrated that sheep grazing a pasture of subterranean clover could ingest sufficient substance of this type to bring about symptoms of œstrogen hyperactivity. The work of Phillips *et al.*[5] directs attention to the effect of climatic conditions on the distribution of both the rate of calvings and of lamb-weights in West Wales. It seems that climatic conditions affect farm animals both directly, and indirectly, through the pasture. Apart from the general basic nutritive differences, it is possible to predict that factors such as the above should be taken into account in assessing these problems.

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The Tricarboxylic Acid Cycle in Nematode Parasites

In nematode parasites the anaerobic breakdown of glycogen to pyruvate and lactate with a consequent formation of adenosine triphosphate follows a course similar to that in vertebrate muscle[1]. Since it appears that aerobic mechanisms may play an important part in the metabolism of certain nematode parasites[2], studies on the carbohydrate metabolism of the parasites have been extended to include some aspects of the oxidative utilization of pyruvate. The organisms used were *Ascaridia galli* from the chicken small intestine and *Nematodirus spathiger* and *N. filicollis* from the sheep small intestine. Some experiments were also carried out with *Neoaplectana glaseri*, a parasite of the Japanese beetle, which, however, was grown *in vitro* for the present experiments. Owing to its relatively large size and its position in the host, *A. galli* may not have an active aerobic metabolism *in vivo*. However, it has been shown that *Nematodirus* spp. probably respire actively *in vivo*, and oxygen is essential for the survival *in vitro* of *Neoaplectana glaseri*.

Experiments were carried out using brei prepared from whole parasites suspended in Krebs – Ringer phosphate buffer at *p*H 7·3. The results were not appreciably affected by omitting calcium from the medium. Oxygen consumption at 38° C., determined by the 'direct' method of Warburg, varied somewhat with different lots of parasites, but Q_{O_2} values (µl. of oxygen taken up per hour per mgm. dry weight, taken over the first period of 30 min.) were usually in the region of 3·8 (*Nematodirus* spp.), 4·0 (*Neoaplectana glaseri*), or 4·2 (*A. galli*). Cytochrome *c* or methylene blue increased oxygen uptake, and, as a routine measure, experiments were carried out with the brei in $M/3,000$ methylene blue.

Co-factors such as co-carboxylase, coenzymes I and II, pantothenate, riboflavin, nicotinic acid and pyridoxine did not markedly affect the oxygen uptake. However, in increasing order of activity the substrates pyruvate, malate, α-ketoglutarate, fumarate and succinate, at concentrations of $M/100$, all caused increased oxygen uptake. Oxalacetate ($M/1,000$) caused a stimulation of the same order as pyruvate. Citrate ($M/100$) had little effect. These results suggest that some form of Krebs tricarboxylic acid cycle was functioning in the parasite tissues. However, compared to pigeon breast muscle, the parasite tissue was relatively insensitive to malonate. Further, results taken over the first 30 min. of an experiment always showed that malonate inhibition was *increased* in the presence of added succinate. When the period of observation was confined to the first 10 min. of the experiment, the effect of succinate on malonate inhibition was less marked; but as a rule, as shown in the accompanying table, inhibition was *increased*. Pyruvate, fumarate and malate, at concentrations of $M/100$, all markedly reduced the inhibition caused by $M/50$ malonate. One interpretation of these results would be that, though a form of the Krebs tricarboxylic acid cycle is functional in the parasite tissues, succinate oxidation, relative to the total oxidative activity, is less important than in pigeon breast muscle.

Effect of malonate and succinate on the oxygen consumption of brei from pigeon breast muscle and nematode parasites. The figures give the percentage inhibition found during the first period of 10 min.

Conditions	Pigeon breast muscle	*Nematodirus* spp.	*Ascaridia galli*	*Neoaplectana glaseri*
Malonate, $M/100$	50–70	25	11	8
Malonate, $M/100$ } succinate, $M/100$	—	40	43	16
Malonate, $M/1000$	30	0–10	0–10	0
Malonate, $M/1000$ } succinate, $M/1000$	5			

The difference in the reaction of the parasite tissues and pigeon breast muscle to malonate was also examined by determining the accumulation of succinate, by the method of Krebs[3], in brei from the different organisms which had been incubated for 1 hr. at 38° C. In the absence of malonate, no succinate was found in the parasite preparations and very little in the breast muscle. However, in $M/100$ malonate, succinate accumulated in the muscle brei but still was not found in the parasite material. Even when $M/100$ malonate and $M/100$ fumarate were added to the parasite brei, succinate accumulation did not occur or was very small indeed.

A detailed account of this work, which was part of the research programme of the Division of Animal Health and Production, Council for Scientific and Industrial Research, will be published elsewhere. A note on the nature of substrates, other than those of the Krebs tricarboxylic acid cycle and the mechanism by which they are metabolized by the parasites, will be published shortly.

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Yellowing Disease of 'Family 41' Sugar Beet

In a preliminary note[1], Clinch, Loughnane and McKay describe a yellowing disease in a breeder's 'pure line' of sugar beet (family 41), which is transmissible through the seed and also by the aphis, *Myzus persicæ*. Recently, Clinch and Loughnane have published a paper[2] on this disease with the title "Seed Transmission of Virus Yellows of Sugar Beet and the Existence of Strains of this Virus in Eire". This title is, in our opinion, misleading, for it suggests that sugar beet yellows virus is transmitted by seed. There is, on the contrary, much evidence that it is not, and though the yellowing of family 41 may be transmitted through the seed, there is nothing to show that the condition is caused by beet yellows virus.

Clinch and Loughnane's conclusion that the yellowing disease of family 41 is beet yellows virus is based solely on symptomatology, particularly on the accumulation of carbohydrates in the yellowed areas of the leaves. However, this is by no means specific to beet yellows virus, nor to virus diseases, for leaves yellowed by downy mildew (*Peronospora schachtii*) are abnormally high in carbohydrate.

In family 41 the symptoms somewhat resemble those of sugar beet yellows; but in field conditions many plants, particularly those which do not inherit the disease, but become infected later, show important distinguishing features. The chlorotic areas are pale; the outlines finely indented with sharply defined lobes and scattered chlorotic spots. With sugar beet yellows the yellowing is brighter, and the outlines of the chlorotic areas are not sharply defined unless bounded by veins. When the disease from family 41 is introduced into other varieties of sugar beet, the symptoms are very weak and ephemeral. Often only one leaf per plant shows any definite yellowing or thickening, and when this leaf dies the plant may be indistinguishable from a healthy one.

Clinch and Loughnane state that the cause of the yellowing in family 41 is transmitted by *M. persicæ* to other sugar beet varieties as readily as mild strains of beet yellows virus. We have not been able to confirm this. Using 10–20 aphides per plant and long feeding times (at least 48 hours on infected and healthy plants) we have never been able to obtain more than 10 per cent of infection in commercial varieties, and often there appears to be no transmission at all. Kleinwanzleben 'E' plants grafted with yellowed plants of family 41 remained apparently healthy. The mild strains of beet yellows virus which we have used[3] are transmitted by comparatively small numbers of aphides after a few hours of feeding.

Sap from plants infected with our mild strains of beet yellows virus is precipitated by antiserum prepared against the severe strains, but saps from yellowed plants of family 41 are not.

Much evidence will be needed before the relationships, if any, between the cause of the yellowing in family 41 and sugar beet yellows virus are understood; but the fact that some seedlings of family 41 have a transmissible chlorosis does not in any way affect the control of sugar beet yellows. There is no reason to consider that beet yellows is transmitted in the seed of any commercial variety of sugar beet; nor is there yet any evidence that the cause of the yellowing in family 41 is transmitted by seed in any of these varieties. Indeed, there is no evidence that the cause of the yellowing in family 41 resulted, in the first place from seed transmission in the normal sense, because it is not known that the parent plants were infected with beet yellows or with any other virus. The phenomenon could be explained on the more interesting hypothesis that the yellowing shown by plants of family 41 has originated in that particular genotype. The sharp definition of the chlorotic pattern suggests an analogy with variegation arising from plastid mutation such as that of maize, described by Rhoades[4]. It suggests also that, if the cause is a virus, it moves with unusual difficulty from cell to cell. This hypothesis might explain the difficulty in infecting sugar beet varieties that regularly become systemically infected with sugar beet yellows.

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Movement of Zooplankton in Diatom Gradients

Hardy and Gunther[1] and Harvey *et al.*[2] have proposed somewhat opposing hypotheses in explanation of a phenomenon widely observed in the sea, namely, an inverse correlation in catches of zooplankton and phytoplankton. Hardy's hypothesis, that of "animal exclusion", is supported in some degree by the experimental work of Lucas[3]; and Harvey's, of the "grazing effect of zooplankton", by various observations on rates of feeding, and statistically by Fleming[4] and others.

The apparatus illustrated in Fig. 1 was devised in order to determine experimentally the behaviour of zooplanktonts when presented, under certain

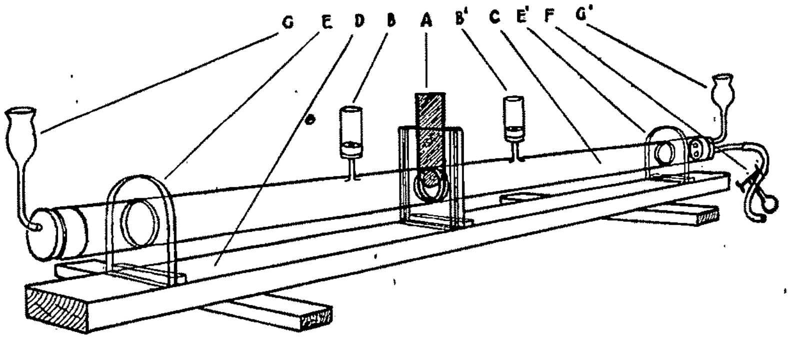

Fig. 1. Perspective view of apparatus. *A*, Sliding door (half open); *B B'*, entrance tubes for animals; *C*, glass tube; *D*, wooden base; *E E'*, 'Perspex' supports; *F*, draining tube with clip; *G G'*, filling funnels for diatom culture

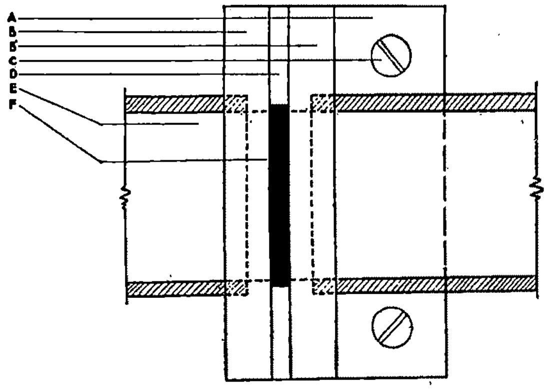

Fig. 2. Working plan of door component. *A*, 'Perspex' supporting bracket; *B B'*, 'Perspex' cheeks recessed for tube; *C*, securing screw; *D*, 'Perspex' spacing piece; *E*, terminal part of glass tube; *F*, sliding door

conditions, with a choice between concentrated diatom cultures and sea water. It consists of a cylindrical glass tube of *c*. 40 in. length and 1 in. diameter, divided in the centre by a removable transparent 'Perspex' sliding door and carrying tubes and funnels for the introduction of cultures and animals. Into one side of this apparatus were put cultures of *Nitschia closterium* (Plymouth strain) grown in sterilized sea water enriched with Allen and Nelson's[5] modification of Miquel solutions. Into the other was put enriched but otherwise pure sea water. Upon opening the sliding door, a visible gradient of diatoms was set up, usually in about the central third of the apparatus, although its length varied with the conditions of the experiment. Zooplanktonts were then introduced in equal numbers into each side and their distribution recorded at intervals for from 1½ hr. variously up to two days. The gradients cannot be observed after about thirty-six hours as movement of the animals tends to destroy them.

Using *Neomysis vulgaris* taken from the River Humber, twenty-eight experiments were performed; eleven with diatoms adapted to growth in 50 per cent sea water and seventeen with 100 per cent sea-water cultures diluted to 50 per cent just before the experiment. No excluding effect of the diatoms could be demonstrated; but a vigorous and often total movement of animals into the diatom side of the apparatus occurred. This movement was most marked with starved individuals and least with fed ones. There was no movement into water immediately filtered from a growing diatom culture, nor was it invoked with water coloured to simulate diatom culture (using pigments shown independently not to be inimical to these mysids), and it did not occur in the dark. There was movement into freshly taken river water (17·5 per thousand salinity) in which living diatoms filtered from a culture had just previously been suspended. Finally, diatoms from a culture were killed by heating to 80° C. for about twenty minutes, filtered off, washed three times on the filter and resuspended in river water. Undiminished movement into this suspension occurred. The number of animals used in each experiment was sixteen, and the diatom cultures were of a concentration of about 1,000 cells per c.mm.

Restricted experiments with *Eurytemora hirundoides* and *Macropsis slabberi* gave similar results, and the movement has also been demonstrated, less effectively, in a vertical apparatus.

The movement of the animals under these conditions seems to be dependent upon the physical presence, in the light, of the diatoms on which they are feeding. These observations provide no evidence in support of Hardy's exclusion hypothesis. It is emphasized, however, that only estuarine animals have been used and that the natural distributions of these particular species have never been shown to be inversely correlated with the occurrence of phytoplankton. The rate of movement of individuals in the horizontal tube, however, was of such an order (*c*. 2 yards per minute) as to be of importance should it be sustained in a constant direction in the sea. It could, were the hypothesis of Harvey correct, be a contributory factor in the production of the grazing effect.

It is intended to apply the technique to an investigation into the relationships of other diatoms and open-sea animals, but this will not be possible for some months, for which reason this preliminary note is now submitted.

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Dec. 30.

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Keeping Lampreys Alive

It has come to my notice that others working on lampreys have had, like myself, difficulty in keeping them alive. Since I have been successful both this year and last in keeping the river lamprey or lampern (*Lampetra fluviatilis*, L.) alive over long periods, the following observations may be of interest.

The essential requirements would seem to be: (1) a liberal supply of oxygen, (2) a means of keeping the temperature of the water below 15° C., (3) absence of direct light.

If the water cannot be artificially aerated, a small number of lampreys (not more than twelve) can live quite well in still water 5 cm. deep providing there is a surface area of not less than 2 square metres. If the depth of water is increased, the lampreys very quickly die from lack of oxygen. Mains water running into a sink with a high overflow often kills lampreys within half an hour.

My stock tank in which I am keeping more than one hundred lampreys measures 7 ft. × 2½ ft. × 3½ ft., and it has 12 in. of water which is kept in constant circulation by a 24-V. D.C., ex-R.A.F. turbine (petrol) pump at one end of the tank, which delivers the water to the top of an aerating tower at the opposite end of the tank at the average rate of 2 litres per minute. The water falls over a series of louvres covered with chicken grit which offers a total surface area of approximately one square metre. The water takes 15 sec. to pass through the tower, the bottom of which is one foot above the level of the water in the tank below.

If the circulation is stopped for as little as one hour, the lampreys are seen to be in respiratory distress, breathing is rapid (more than 200 per minute) and shallow, the lampreys fall over on their sides and are unable to right themselves or to grip with their sucker. If the circulation is then restarted, the lampreys recover completely within two or three hours.

My tanks are of heavily galvanized iron and rest on a stone floor in a basement room which is kept cool by a through draught of air. Last winter the outside windows were closed in error one week-end. This caused the temperature of the water to rise from 13° C. to 22° C., and despite the fact that the water was still circulating all the lampreys had died.

The high sides of the tank cut out direct light and keep the lampreys from jumping out when they are being netted.

Details of the apparatus and experiments will be published elsewhere.

Note added in proof. The pump mentioned above has since been replaced by a $\frac{1}{3}$ h.p. A.C. centrifugal pump which needs little servicing.

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Feeding-Rates of Sponges, Lamellibranchs and Ascidians

MANY water-living animals obtain their food from suspended material, micro-organisms or fine dispersed detritus occurring in the surrounding water. Sponges and ascidians, for example, are typical filtering animals. Most lamellibranchs belong to the same group. But filtering forms may also be found among gastropods, crustaceans, insects, polychætes, vertebrates, etc. Apart from lamellibranchs, little information is available regarding the rate and efficiency with which particles are retained from water passing the filtering organs. Bidder[1] calculated the water propulsion through *Leucandra aspersa* (a sponge), whereas investigations on the rate of feeding of ascidians seems to be lacking. During a stay at the Plymouth Laboratory, I was offered an opportunity of determining the feeding-rates of species of sponges and ascidians. The feeding-rates have been calculated from the rate of disappearance of particles from the surrounding water[2]. Suspensions of colloidal graphite were used, namely, 'Prodag' grade C and 'Aquadag' grade S, manufactured by E. G. Acheson, Ltd., London; the former has an average particle size of 4–5 μ, whereas the latter has an average particle-size of 2 μ. The concentrations of the graphite suspensions were determined photometrically by means of a portable Eel photometer.

The results of the experiments are given in the accompanying table. The feeding-rates are expressed as per mgm. of amino-nitrogen of the experimental animals instead of the normally used weight and length or similar measurement, which provide an unsatisfactory basis for comparisons between animals. In the table are also included results obtained on *Mytilus edulis*, which will be published in greater detail elsewhere[3]. It is seen that—when expressed in relation to the amino-nitrogen content, which may be regarded as a measure of the amount of protoplasm in the animals—the feeding-rates of the species investigated are all of the same order of magnitude, *Halichondria* and *Mytilus* showing somewhat lower values. However, the experiments on *Halichondria* were carried out on a fragment weighing about 50 gm., whereas the calcareous sponges used were all smaller intact specimens.

Species	Number of animals in each experiment	Length (cm.)	Average content of amino-nitrogen (mgm.)	Feeding-rate ml./hr., per mgm. amino-nitrogen
Ascidians				
Molgula sp.	20	1–2	1·8	138, 124, 285, 118, 149, 115
Ciona intestinalis (L.)	2	6–7	6	125, 92, 104
,, ,, ,,	3	6–7	5·3	125
Sponges				
Grantia compressa (Fabricius)	1	7	8·5	135
,, ,, ,,	9	3–7	3·3	180
Sycon coronatum (Ellis and Solander)	9	4–6	2	200, 145
Sycon + *Grantia*				170
Halichondria panicea (Pallas)				65
Lamellibranchs				
Mytilus edulis (L.)		*c.* 3	25	36
,, ,, ,,		*c.* 1·5	2	80

The feeding-rates of sponges and ascidians were found to be independent of the particle-size, which varied from about 2 μ and 4·5 μ respectively and upwards. The upper limit of the particle-size in the suspensions was not known, as the graphite did not form fully dispersed suspensions in sea water. A certain amount of aggregated particles was always observed when the suspensions were examined under the microscope.

As regards the ascidians, the independence of feeding-rate and particle-size is in good agreement with the view held by MacGinitie[4] concerning the feeding mechanism of ascidians. He observed that ascidians when feeding are covering the gill basket with a continuous layer of mucus which retains all particulate matter in the water transported through the gills.

My thanks are due to the director, Wing-Comdr. F. S. Russell, for placing the working facilities of the Plymouth Laboratory at my disposal, and for his great interest in my work. The investigations were made possible through a grant from the Rask–Ørsted Foundation.

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Varagu Poisoning

Varagu (Tamil), *kodo*, *kodaka* (Hindustani), *Paspalum scrobiculatum* (Linn.), is a millet largely used by the working and poorer classes of people in all parts of India as a staple article of food. More than 300,000 tons of this millet is produced in the Madras Presidency alone. In 1946, when rice was rationed and millet eaters were compulsorily asked to take a portion of their requirements in rice and millets in the form of *varagu*, complaints were received that consumers in several parts of the Presidency developed symptoms of food poisoning as a result of eating *varagu* in the cooked as well as the raw state.

The symptoms observed within twenty minutes of taking the food were tremors, giddiness, perspiration, inability to speak or swallow. There were no fatalities, and the symptoms disappeared after twenty-four hours, though the persons affected had to be taken to hospital for treatment.

It was difficult to feed monkeys, as they refused to take the food. Two ounces of the millet produced the same symptoms on dogs; tremors and paralysis were characteristic effects, and the dogs died in twenty-four hours. The Stas Otto test was negative, showing the absence of alkaloids. The fat was extracted with petroleum ether (60–95° C.), or chloroform, or ether, and it was found that 1·5 gm. of fat corresponding to 50 gm. of the millet were fatal to dogs. The fat had the following figures (average):

Melting point	42° C.
Refractive index (60° C.) ..	1·4650
Iodine value	93·6
Saponification value	170·7

The defatted residue was found to be non-toxic. The poison in the fat seems to be decomposed by dilute acid and alkali, as after acid and alkali treatment the treated fat is no longer poisonous. The liquid, decanted after shaking the millet with petroleum ether, develops a characteristic red colour when shaken with concentrated sulphuric acid. But as the fat in the millet after treatment with dilute acid—when it is no longer poisonous—still gives the colour test, it is inferred that the colour observed is not due to the poison in the fat but to a decomposition product of it. The poison seems to be neither an alkaloid nor a glucoside, as it is not extracted with acid, water or 90 per cent alcohol. It seems to be adsorbed chromatographically in silica column. Further work is in progress.

The fat obtained from non-poisonous varieties of *varagu* is quite harmless, and does not give the sulphuric acid test described above.

The most surprising observation is that the fat derived from the poisonous variety develops symptoms of poisoning in dogs and monkeys when injected intramuscularly, 1 gm. of the fat being fatal. Crows seem to be extremely susceptible to the poison in the fat, either when ingested orally or injected intramuscularly. Within ten minutes of oral ingestion, the crow puts down its beak and vomits; even after all the contents have been vomited the crow puts down its beak in an effort to vomit. It loses the mobility of its eyes and soon its power of using its legs, while the wings are spread out and can no longer be brought together. The crow dies in twenty-four hours. The effects are slow when the fat is given by injection; but the collapse is more pronounced and the symptom of vomiting, even when there is nothing to vomit, is a characteristic of the poisoning in the crow.

These observations do not appear to have been recorded so far in the literature. They give a means of distinguishing the poisonous from the non-poisonous variety, and it should lead to the reclamation of an important article of food which, of late, has come into disrepute owing to the ill-effects attending its consumption.

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Rh Phenotypes and Fisher's *CDE* Notation

Since the introduction of Fisher's theory and notation[1] of the *Rh* blood-group system, the tendency has been to express phenotypes in terms of the probable genotype. This method is most convenient for European populations, where every common phenotype consists very largely of a single genotype; but its extension to non-European populations usually involves serious ambiguities. In this and other connexions, there is an undoubted need for an unambiguous and generally understood phenotype notation expressed in Fisher's symbols, which would be available to supplement current practices. Several attempts have been made to express phenotypes with the use of these symbols, probably the earliest being that of Bushby[2]. The present proposals closely resemble those of Bushby; but allowance is here made for the fact that the six typing sera (anti-*C*, *D*, *E*, *c*, *d*, *e*) are not usually all available as Bushby tacitly assumes. No originality is claimed for these proposals; it is probable that other workers have thought of and used them independently; and, in fact, when recently I was discussing an *Rh* problem with Dr. M. Bessis of Paris, we found that we had both for some time been using this system in working out *Rh* problems.

The phenotype formula is derived as follows: considering first the *C* locus of Fisher, if a specimen of blood has been tested with anti-*C* alone and the result is positive, a single *C* is written. If the result is negative, *cc* is written, whether or not the blood has been tested with anti-*c*, since a negative result with anti-*C* indicates the presence of two *c* genes. If the blood has been tested with anti-*C* and anti-*c* and both give positive results, *Cc* is written. If the result with anti-*c* is negative, *CC* is written, and this can be done even in the absence of a test with anti-*C*. The *D* and *E* systems are treated similarly. But if both the antisera required for one particular system (for example, *Ee*) are unavailable, the statement of the results (for example, *Ccdd*) makes this quite clear. To take a concrete example, let it be supposed that blood of the genotype *CDe/cde* is being tested with the commonest four antisera, namely, anti-*C*, anti-*c*, anti-*D* and anti-*E*, the results will, in that order, be + + + − and the phenotype will be written *CcDee*. The only available information which is missing from this expression of the results is as to whether the blood has been tested with anti-*e*; but the negative result with anti-*E*, in fact, makes such knowledge irrelevant. The absence of a second *D* symbol (*D* or *d*) shows that no test has been done with anti-*d*.

The above suggestions only relate to the common antigens *C*, *D*, *E*, *c*, *d*, and *e*, in respect of which all the suggested conventions appear self-evident. In order to deal with the rarer alleles such as *Cw*, it would be necessary deliberately to adopt certain further conventions by agreement between the workers concerned.

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Triassic Plant Remains from the Salt Range in the Punjab

DR. SITHOLEY[1] has described some "bivalved structures" from the Triassic of the Salt Range in the Punjab, which he says "are remarkably like the alga *Cosmarium*"; but he admits that "the latter is far too small to be compared with them". He then compares these structures to Arnold's Greenland organism "undergoing fission". From his description and the photographs, however, I was inclined to think that these structures could best be compared with some two-winged spores, with which they agree both as regards their size and their shape and general appearance.

With the view of confirming my doubts, I examined some of Dr. Sitholey's beautifully coloured specimens which he was kind enough to show me, and I am now convinced that this so-called "most intriguing type" should be referred to *Pityosporites* Seward, a spore form which was fairly common in the Lower and the Upper Gondwana floras[2]. Similarly, the "disc-like bodies" (Sitholey, *loc. cit.*, p. 322, and photos 58–60) found in "fairly large numbers" are, I believe, one-winged spores with a central body and a peripheral bladdery wing forming the "thick wing" (due to the formation of a cast of the air cavity). Similar one-winged spores are one of the commonest types in the Lower Gondwana beds[3]. Dr. Sitholey, while mentioning that these might be "some kind of spores", adds that "there is no real proof of their organic nature"; but it might be said that the proof is as good for these as it is for the other types which have been referred by him to the spore genera *Triletes* and *Sporites*.

It seems that the conditions of fossilization, at this spot, were very suitable for the formation of casts, and they have been formed even in the case of such minute structures. The occurrence of almost identical two-winged, one-winged and other spores (*Triletes*, *Sporites*, etc.) in the immediately preceding Lower Gondwana beds not only confirms the above conclusions but also might perhaps indicate some relationship between these two floras, a thing which is in accord with the views of Seward and Sahni[4]. The relative frequency of the various types of spores in the two floras has, however, to be determined before this can be said with any certainty.

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Formation of Citrate *in vivo* Induced by Fluoroacetate Poisoning

THE intensely toxic action of the rat poison sodium fluoroacetate ($CH_2F.COONa$) upon the central nervous system and heart is of special interest because of the stability of the carbon – fluorine link. Bartlett and Barron[1] have suggested that it competes with acetate ion in intermediary metabolism, and Saunders[2] and colleagues that larger chain compounds of this type must be convertible to $CH_2F.CO$ to show toxicity. Recently Liébecq and Peters[3,4] using centrifuged guinea pig kidney homogenates have found that the oxidation of citrate formed from fumarate is inhibited by fluoroacetate. They have proposed the further hypothesis that this poison is metabolized like acetate and enters the tricarboxylic cycle, eventually 'jamming' this and causing accumulation of citrate.

We have now obtained further evidence for this hypothesis *in vivo*; rats injected with sodium fluoroacetate show relatively large accumulations of citrate in heart, kidney and brain tissue.

	Citric acid (γ)/gm. fresh tissue	
	Normal	Poisoned
Heart	(10) 0–58	(7) 558–810
Kidney	(8) 0–48	(8) 854–1220
Brain	(7) 0–46	(7) 118–271

Figures in brackets indicate the number of animals tested. Dose Na–FAc = 5 mgm./kgm. body-weight intraperitoneally; animals killed 1 hour after the injection. The method of Pucher *et al.*[5] was used for citrate estimation, after boiling with acid; 'alkali heating' did not destroy the substance estimated (see Breusch and Tulus[6]).

This is interesting support both for the hypothesis proposed and also for the existence of a tricarboxylic acid cycle as a metabolic path *in vivo*.

We are grateful to Dr. B. C. Saunders for the fluoroacetate used.

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Influence of Aneurin and Aneurin Pyrophosphate on Anaerobic Pyruvate Metabolism of Pig Heart Muscle *in vitro*

IN the course of investigations on the anaerobic metabolism of pyruvate by minced pig heart muscle we made some observations on effects of aneurin and aneurin pyrophosphate, which we think worth recording in this preliminary note. We will discuss only the influence of both compounds on carbon dioxide production, and postpone the description of effects observed on the formation of other metabolic products such as lactic acid, acetoin, etc.

The carbon dioxide production of Latapie-mince of the muscle of the left ventricle, suspended in phosphate buffer, *p*H 6·2, containing manganese ions was measured in the Warburg apparatus at 38° C. Each vessel contained 330 mgm. of tissue; 2 mgm. sodium pyruvate was tipped in from the side-bulb. The mince was examined when fresh and also after having been stored during varying times at + 1° C.

Without added pyruvate, the carbon dioxide production was of the order of 10 mm.³ in three or four hours; it was not influenced by adding aneurin pyrophosphate or aneurin.

The accompanying tables show the results of a few representative examples of the numerous experiments, which gave similar results without exception. The accuracy of all our measurements is similar to that shown in Table 2, in which duplicates and riplicates have been recorded.

Table 1

Heart	Condition of tissue	mm.³ CO_2 in 180 min.		% increase of CO_2 prod.
		no APP* added	5γ APP added	
A	fresh	170	186	10
	stored 24 hr.	157	200	28
	stored 48 hr.	110	151	40
B	fresh	208	214	3
	stored 48 hr.	143	192	40

* APP = aneurin pyrophosphate.

Table 1 demonstrates the effect of aneurin pyrophosphate. With fresh mince the effect is very small. It increases with increasing time of storage of the mince at + 1° C. Obviously during storage the aneurin pyrophosphate is split off from one or more enzymes associated with carbon dioxide production n anaerobiosis. The enzyme(s) can be formed again from added aneurin pyrophosphate and the bearer(s) still present. The liberated aneurin pyrophosphate will have been decomposed by the tissue phosphatase. We were able to establish that the aneurin pyrophosphate content of the tissue diminished during storage at + 1° C. We believe the most important result of these experiments is the method it indicates for reversibly removing part of the aneurin pyrophosphate from some bearer(s) in the tissue.

Storage at other values of *p*H or temperature gave much less satisfactory results.

Table 2

		mm.³ CO_2 in 240 min.			
		Heart *C* (fresh)		Heart *D* (fresh)	
I	no aneurin no APP	205, 211	*208*	188, 198	*193*
II	6γ aneurin no APP	202, 205	*203*	194, 192, 193	*193*
III	no aneurin 5γ APP	214, 215, 217	*215*	209, 206, 205	*207*
IV	6γ aneurin 5γ APP	236, 240, 241	*239*	222, 221, 217	*220*
% increase (IV–III)			*11*		*7*

Table 2 concerns the effect of aneurin. This is only seen with fresh mince in the presence of added aneurin pyrophosphate. The aneurin cannot be replaced by equivalent or greater amounts of aneurin pyrophosphate. Possibly this effect indicates the formation of some unknown prosthetic group, which might be a dinucleotide, consisting of aneurin pyrophosphate and aneurin. It is not possible to ascribe the effect of aneurin to the formation of aneurin pyrophosphate by fresh tissue particles, which are impermeable to the pyrophosphate, as simultaneous addition of the pyrophosphate is necessary in order to detect any aneurin effect. Nor can it be explained by inhibition by aneurin of phosphatase action on aneurin pyrophosphate. This inhibition has provided the explanation of the activation by aneurin of carbon dioxide production by alkaline-washed yeast, magnesium ions and aneurin pyrophosphate[1]; but according to Westenbrink *et al.*[2], rat tissue phosphatases are not inhibited by aneurin, even in very large amounts. We were able to confirm these results for pig heart muscle.

Table 3

Heart	Condition of tissue	mm.³ CO_2 in 180 min.				
		no APP no aneurin	no APP 1000γ aneurin	5γ APP no aneurin	5γ APP 6γ aneurin	5γ APP 1000γ aneurin
E	fresh	164		180	194	180
E	stored 48 hr.	153	132			
F	fresh	161	147	163	183	166
G	stored 72 hr.			201		187
H	72 hr.	92	73			
I	120 hr.	156	126	194		179

Table 3 shows the depressing effect of large amounts of aneurin on carbon dioxide production. This effect is observed with mince stored at + 1° C. as well as with fresh mince. We believe this effect to be due to partial replacement of aneurin pyrophosphate on its bearer(s) by aneurin. It can be reversed by larger amounts of the pyrophosphate.

This work forms part of investigations on the metabolism and physiological action of aneurin being carried out by Prof. H. G. K. Westenbrink and collaborators. Full details will be published elsewhere.

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Piezo-electric Coefficients of Ethylene Diamine Tartrate

WE have determined the elastic and piezo-electric coefficients of anhydrous ethylene diamine tartrate by measurements of the resonances of bars, and of square plates, cut at various orientations to the axes of the crystals. To find the piezo-electric coefficients, we have measured the capacitance of each specimen over a range of frequencies differing from the resonance frequency by ½–3 per cent. Although all the coefficients can be deduced from eighteen specimens[1], we have used more than fifty different specimens so as to confirm our results fully.

Our values for the elastic coefficients agree substantially with Mason's[2]; but some of our values for the piezo-electric coefficients differ greatly from his. The following table includes also some results obtained by Jaffe by a statical method[3].

Piezo-electric coefficients × 10^8, C.G.S. E.S.U.

	Mason	Jaffe	New measurements
d_{14}	23·5		− 31·1 ± 0·8
d_{16}	37		− 36·5
d_{21}	34	33·9 ± 3	30·6 ± 0·5
d_{22}	− 20	5·4 ± 1·5	6·6
d_{23}	31	− 36·9 ± 3	− 33·8 ± 0·4
d_{25}	14	− 55·2 ± 6	− 54·3 ± 0·8
d_{34}	37·5		− 51
d_{36}	50		− 56·9 ± 1·8

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Interferometric Determination of the Apparent Thickness of Thin Metallic Films

Khamsavi and Donaldson[1] have described an interferometric method for the measurement of the apparent thicknesses of thin metallic films (200–700 A. in thickness). The method described was essentially that due to Wiener[2], modified to bring in the advantages of the sharp interference fringes obtained when multiple-beam interferometry is used[3]. An opaque reflecting layer is deposited over the edge of the film to be measured, and the step in this layer is measured by using it as one surface of an interferometer, and viewing this in reflexion using either fringes of equal thickness or fringes of equal chromatic order. By combining these thickness measurements with colorimetric determinations of the mass deposited upon a given area, they showed that the density of the film appeared to remain constant and equal to that of the bulk metal (silver) down to quite small thicknesses (122 A.).

As they themselves pointed out, however, this may be argued to be a necessary result, since the films used probably have small-scale discontinuities in their structure[4], and the deposition of an opaque reflecting layer over the film to be measured serves to fill up the interstices in that film until its structure resembles that of the opaque film, and hence its density appears to be that of the bulk metal. Some experiments described here tend to confirm this view.

In these experiments a thin film of silver, A_1 (Fig. 1), was laid down on to a substrate either of silver (previously deposited by evaporation to a thickness of about 1000 A.), or of glass, and over the edge of this, two opaque layers B_1 and B_2 were deposited side by side, one of silver and one of some other metal. If the 'packing-in' effect suggested above takes place, it might be expected that the steps in B_1 and B_2 would not be of the same height. This has, indeed, been found to be the case. Four typical measurements with the layer B_2 consisting of chromium, given in the accompanying table, show the magnitude of this effect.

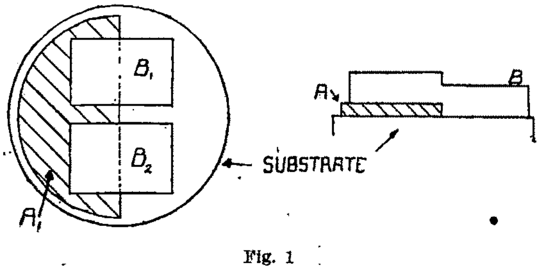

Fig. 1

Substrate	Step in B_1	Step in B_2	b	$\frac{b}{b_1} \times 100$
Silver	247	312	65	26
Silver	470	569	99	21
Glass	202	279	77	38
Glass	377	504	127	34

Typical sets of multiple-beam interference fringes of equal thickness running over the steps in B_1 and B_2 are shown in Fig. 2. Owing to the relatively low reflectivity of the chromium layers, the fringes obtained over B_2 are very broad, and the accuracy o the measurements throughout is not greater tha $\pm$ 25 A.

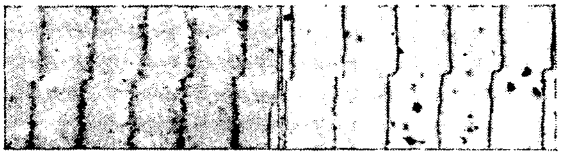

Fig. 2. Fringes with (*a*) chromium; (*b*) silver

These results show that measurements of th thinner film thicknesses obtained by this metho should be treated with caution, since errors of th order of 30 per cent at least may occur, possibl greater. The limitations of the method should there fore be recognized. It should be noted, however, tha the method of Khamsavi and Donaldson, because o the constancy found for the apparent density, afford an accurate means of estimating the mass deposite per unit area in a given film, provided that the laye deposited over the edge of the film is of the same meta as the film itself.

I wish to express my thanks to Prof. S. Tolansky under whose direction this work was carried out and to the Department of Scientific and Industria Research for provision of a maintenance grant.

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Absorption Spectra, Molecular Weights, and Visual Purple

HOUSTON[1] has shown that, in the case of absorbin media, the number p of electrons per molecule o solute giving rise to an absorption band with maximum at the wave-length λ_m is given by

$$p = \frac{4\pi n k_m}{s} \cdot \frac{m}{e} \cdot \frac{m_H}{e} \cdot \frac{\lambda' - \lambda_m}{\lambda_m^3}, \quad (1$$

where e and m are the electronic charge and mas respectively, m_H the mass of the hydrogen atom, n th refractive index of the solution at λ_m, k_m the absorption coefficient at λ_m, s the concentration in gram molecules per c.c., and λ' the wave-length at whic the absorption index is half the value k_m. Housto calculated p for some thirty substances, and foun values between 0·1 and 1 in eighteen cases; betwee 1 and 2·7 in four cases; and considerably less tha unity in the remaining cases.

In other words, in the great majority of solution p is about unity or less. This fact offers a new method for the estimation of the molecular weight of substances having an absorption band in the visible o ultra-violet part of the spectrum, for, if we assum $p = 1$, equation (1) becomes on rearrangement

$$M = 0\cdot4343\left(\frac{e}{m}\right)\left(\frac{e}{m_H}\right)\frac{w}{v}\frac{1}{Dn}\cdot\frac{\lambda_m^2}{\lambda' - \lambda_m}, \quad (2)$$

where D is the photometric density, connected with λ_m by

$$D = \log_{10} I_i/I_t = 4\pi \times 0\cdot4343\, k_m\, x/\lambda_m.$$

I_i and I_t are the intensities of the incident and ransmitted radiations respectively, x being the thickness of the transmitting layer; v is the volume of he solution; w the mass of the solute.

Houston's calculations of p were made on subtances of relatively low molecular weight. Before applying the transposed formula (2) to visual purple, it is advisable to check it with a substance of known high molecular weight. Reduced hæmoglobin is suitable for this purpose, because it has a single absorption band in the visible part of the spectrum; thus the effect of other bands in the ultra-violet and, possibly, near infra-red, can be neglected. The values[2] ${}_m = 5550$ A., $\lambda' = 5850$ A., $w/v = 0\cdot01$ gm./c.c., $= 1\cdot33$, $D = 8\cdot1$, $x = 1$ cm., $e/m = 1\cdot76 \times 10^7$ E.M.U., $e/m_H = 9\cdot57 \times 10^3$ E.M.U., and $p = 1$ yield $M = 69{,}500$. This excellent agreement with the gure 68,000 obtained by other methods gives condence both in the applicability of the expression (2) o the determination of molecular weights of this rder of magnitude and also in the assumption that p, the number of electrons per molecule responsible or the mechanism of absorption, is approximately nity. It should be stressed that M is proportional o p; that is, if p is assumed to be $\frac{1}{2}$, the value of M as derived from (2) will also be halved.

Considerable interest centres around the other chromoprotein mentioned above, namely, visual urple. Found in the retinal rods of nearly all verterates and a number of invertebrates, this substance is intimately concerned with the physico-physioogical mechanism of scotopic or twilight vision. It as an absorption maximum at 5020 A. in the visible nd another in the ultra-violet part of the spectrum. As in the case of hæmoglobin, this results in a slight symmetry, and λ' is, therefore, chosen on the long-wave-length side of λ_m also in this case. In this manner the possible contribution from the ‘ultra-violet’ chromophore to the extinction is reduced to a minimum. The molecular weight of visual purple was calculated from the best set of data given by Broda, Goodeve and Lythgoe[3]: $\lambda_m = 5020$ A., $\lambda' = 5480$ A., $w/v = 2\cdot53 \times 10^{-3}$ gm./c.c., $n = 1\cdot33$, $D = 1\cdot67$. The molecular weight of visual purple derived in this manner is 45,600. This is to be compared with the value of 270,000 obtained by Hecht and Pickels[4] using the ultra-centrifuge. In this latter determination considerable difficulty was encountered owing to the formation of micelles of high ‘molecular weight’ by the stromalytic and dispersing agent employed in preparing the visual purple solutions.

Using Hecht and Pickels's value for the molecular weight of visual purple, Broda, Goodeve and Lythgoe[3] calculated that the number of chromophores associated with the protein carrier was ten, assuming that the carrier weight R—the molecular weight per chromophore—was 26,500. This calculation also presupposed that the quantum efficiency of the photochemical reaction taking place on exposing visual purple to light is unity[5].

If the new value for the molecular weight, $M = 45{,}600$, be accepted, the number of chromophores associated with the protein carrier is calculated to be $1\cdot7$. There is reason to believe that the above value for M may be somewhat low; Broda, Goodeve and Lythgoe point out that their value for R should, in effect, be slightly lower: on the above basis it can thus be assumed that there are two chromophores in each molecule of visual purple.

Broda and Goodeve[6] determined the absorption spectrum of visual purple at a low temperature (− 73° C.). At this temperature λ_m moves from 5050 to 5150 A., and the curve becomes narrower, λ' being at 5340 A. Although the concentration of the solution is not given, these authors established the identity at room temperature between the absorption spectra of visual purple dissolved in water and in a 3 : 1 mixture of glycerol and water. Moreover, they demonstrated the reversibility of the changes in the absorption spectrum as effected by the change in temperature.

It seems, therefore, justifiable to calculate the ratio of the molecular weight at room temperature to that at − 73° C., and this is found to be $M_R/M_{-73^\circ\,\text{C.}} = 0\cdot422$.

Considering the approximate nature of these calculations and the empirical bases on which they partly rest, a discussion of the significance of this apparent dimerization is unlikely to prove fruitful at present.

I would like to thank Dr. H. J. A. Dartnall of this Unit for valuable discussions, and Dr. J. G. Wootton, British Postgraduate School of Medicine, London, W.12, for kindly supplying me with his data on hæmoglobin.

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Knock in Internal Combustion Engines

THE information given in the two letters[1] on the above subject by D. Downs and A. D. Walsh confirm and considerably extend, with improved equipment and procedure, the observations and conclusions to which the authors refer in the paper by Egerton, Smith and Ubbelohde[2]. In that work it was found that nitrogen peroxide appeared to promote knock when the engine was run with hydrogen, and it was, indeed, suggested that the nitrogen oxides, in the circumstances, tended to sensitize the mixture. Lead tetraethyl was not found to suppress the knock. A fixed-compression Delco engine (6·75 : 1) had been used, and it now appears probable that the conditions were such as gave pre-ignition rather than true knock, and that lead tetraethyl has little effect in inhibiting the pre-ignition but prevents the knock. It would be interesting to test whether hydrogen will knock when no nitrogen or organic vapours are present (for example, using an argon atmosphere and a minimum of lubricating oil).

Our more recent experiments in a Gardner $1L2$ compression ignition engine converted to spark ignition confirm that nitrogen peroxide has a strong pro-knock effect when added as a vapour to methane-air mixtures. The pronounced pro-knock effect of hydrogen peroxide vapour on methane was also investigated with the same engine. Definite audible knock could be produced with a molecular concentration of 0·3 per cent of the methane. It was found that the pro-knock effect could be suppressed by lead tetraethyl. Similarly, when running on weak hydrogen–air mixtures in this engine, the knock was suppressed by lead tetraethyl, confirming, therefore, Downs's and Walsh's observations, and also that the knock induced by nitrogen peroxide in such mixtures could be similarly suppressed.

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[2] *Phil. Trans. Roy. Soc.*, 4, 33 (1935).

Dehydrochlorination and Insecticidal Action in Chlorinated Hydrocarbons

EARLY in the history of D.D.T., Martin and Wain[1] suggested that easy dehydrochlorination is necessary for insecticidal action in chlorinated hydrocarbons. This generalization has since been extended to benzene hexachloride, to chlorinated indanes and terpenes. A new group of insecticides, introduced by Julius Hyman and Co., of Denver, Colorado, provides an exception to this rule. For example, 'Compound 118', stated to be 1,2,3,4,10,10-hexachloro-1 : 4,5 : 8-diendomethano-1,4,4*a*,5,8,8*a*-hexahydronaphthalene, is stable to alcoholic potash yet is of the same order of insecticidal activity as D.D.T. Fed to caterpillars of *Mamestra brassicæ*, it was toxic at 0·14 ± 0·003 mgm. per 0·5 gm. larva, the toxic dose of D.D.T. being 0·06 ± 0·011 mgm. To adult *Calandra granaria* walking on filter paper impregnated with oil-solutions of the insecticides, the relative magnitude of the median effective doses (D.D.T. : 'Compound 118') was, after 68 hr., 4·5 : 1 ; after 90 hr., 2·5 : 1 ; after 120 hr., 1 : 1 ; and after 140 hr., 0·8 : 1. This difference in speed of action and differences in the reactions of the poisoned insects indicate that the two insecticides are dissimilar in their modes of action.

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[1] *Nature*, 154, 512 (1944).

Persistence of Optical Activity in an Oxidation-Reduction Reaction

TRIS-O,PHENANTHROLINE ruthenium^{II} perchlorate dihydrate[1], $Ru(phenan)_3(ClO_4)_2.2H_2O$, has been resolved through the antimonyl tartarate to give $[\alpha]_D^{20} = +979°$ and $-971°$ and $[\alpha]_{546·1}^{20} = +1869°$ and $-1863°$ for the ion $Ru(phenan)_3^{++}$. Burstall[2] found $[\alpha]_{579·1}^{25} = +860°$ and $-815°$ for the compound $Ru(dipy)_3I_2.2H_2O$. The orange-red active perchlorates in 6 normal sulphuric acid were oxidized with ceric nitrate to yield the optically active blue ion $Ru(phenan)_3^{+++}$, for which $[\alpha]_D^{20} = +311°$ and $-303°$ and $[\alpha]_{546·1}^{20} = +1,246°$ and $-1,256°$. Reduction of the unstable oxidized ion with ferrou sulphate regenerated the ruthenium^{II} complex wit its rotation unchanged. It is evident that both th di- and tri-valent ruthenium complexes have a ver large abnormal rotatory dispersion.

These observations provide a unique demonstratio of the essential similarity of the oxidized and reduce forms of the complexes, as well as of the simplicit of the oxidation-reduction reaction. It is of interes to note that, within an accuracy of about ± 5 mV. the optical forms and the racemate have the sam redox potential.

The ferrous complex ion $Fe(phenan)_3^{++}$ was als isolated in optical forms, but the rotation was los on oxidation due to the lower stability of the oxidize form.

Complete details will be published shortly in th *Journal of the Royal Society of New South Wales.*

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Dec. 13.

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[1] Dwyer, Humpoletz and Nyholm, *J. Proc. Roy. Soc., N.S.W.*, 80, 21 (1947).

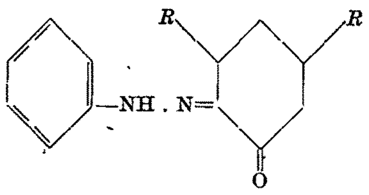
[2] Burstall, *J. Chem. Soc.*, 172 (1936).

A New Synthesis of Cinnoline Derivatives

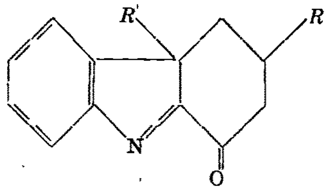
IN connexion with an investigation on th elaboration of the Coffey[1] synthesis of 1-ketotetra hydrocarbazoles, a study of the action of acidi reagents on a number of 1 : 2-*cyclo*hexadionemonc phenylhydrazones of the type (I) has recently bee undertaken. Although it has not so far prove possible to obtain 1-ketotetrahydrocarbazolenines (I by this means, an interesting synthesis of cinnolin derivatives has come to light.

4 : 6-Dimethyl-1 : 2-*cyclo*hexadione-1-phenylhydrazone (I, $R = Me$) (red prisms from methy alcohol, m.p. 58–9° ; found : C, 73·1 ; H, 7·4 N, 11·9 ; $C_{14}H_{18}ON_2$ requires C, 72·9 ; H, 7·8 N, 12·2 per cent), which has been prepare by application of Coffey's general method (*lo cit.*), is smoothly cyclodehydrated on dissolutio in concentrated sulphuric acid to 2 : 4-dimethy 1 : 2 : 3 : 4-tetrahydrobenzocinnoline (III, $R = Me$ The base (III, $R = Me$) (yellow needles from ligroin m.p. 111° ; found : C, 79·3 ; H, 7·7 ; N, 13·0 $C_{14}H_{16}N_2$ requires C, 79·3 ; H, 7·5 ; N, 13·2 pe cent) may be isolated with ether, in 85 per cent c the theoretical yield, after addition of water an excess alkali to the reaction mixture. 1 : 2-*cyclo* Hexadione-1-phenylhydrazone (I, $R = H$) may likewise be converted to 1 : 2 : 3 : 4-tetrahydrobenzo cinnoline (III, $R = H$) (yellow prisms from ligroin m.p. 98° ; found : C, 78·1 ; H, 6·6 ; N, 15·3 $C_{12}H_{12}N_2$ requires C, 78·3 ; H, 6·5 ; N, 15·2 pe cent), but the yield in this case is only 15 per cen of theory, a large amount of amphoteric materia being produced simultaneously.

In order to widen, if possible, the scope of th new method, the action of sulphuric acid on benzi monophenylhydrazone (IV) was next investigate The use of 98 per cent sulphuric acid led to extensiv decomposition; but, by employing slightly dilute acid (75–80 per cent w./w.), the non-basic 3 : 4 diphenylcinnoline (V) (yellow prisms from ethe m.p. 149–50° ; found : C, 84·9 ; H, 5·0 ; calc. fc $C_{20}H_{14}N_2$, C, 85·1 ; H, 5·0 per cent) may be obtaine



I



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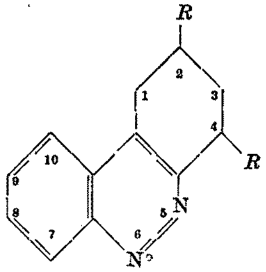

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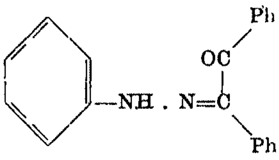
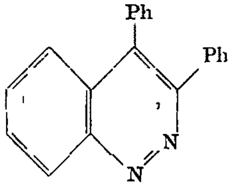
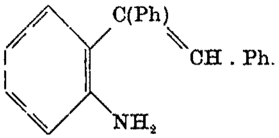


IV



V



VI

in yields of 75 per cent of theory. This compound has already been described by Simpson[2], who obtained it from α(2-aminophenyl)-α : β-diphenylethylene (VI) by diazotization.

When applicable, the new method illustrated by the above examples is more convenient than those previously available.

I am indebted to Sir Robert Robinson for his interest in the investigation.

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Dec. 17.

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Influence of Solvent Movement on Sedimentation

ENOKSSON[1] has maintained that the major factor which causes the sedimentation constant of a protein to change with concentration is the counterflow of solvent, which is a necessary result of the sedimentation of the protein. He ascribed to the same cause the differences of sedimentation-rate in terms of which two of us[2] have accounted for the boundary anomalies observed in the sedimentation of mixtures. Pedersen[3] has repeated Enoksson's arguments.

We[2] were aware of this effect; but we consider that it can account only for a minor part of the change of sedimentation-rate with concentration, on the following grounds:

(1) The values of φ, the specific sedimentation volume, which have to be assumed are unreasonably large, and, moreover, are inconsistent with each other and with other data. For example, the value of φ obtained by Enoksson from our data[2] on the variation of the sedimentation constant of serum albumin with concentration should be 5·4 ml./gm. (Enoksson, in his Table 1, wrongly quotes a value of 10 ml./gm.); the value obtained for serum albumin from the boundary anomaly in mixtures with lactoglobulin is correctly calculated by Enoksson as about 11 ml./gm.; the maximum value consistent with the sedimentation constant of serum albumin at zero concentration ($4\cdot5 \times 10^{-13}$), by applying Stokes's law, is 1·5 ml./gm.

(2) The sedimentation constant should, on this theory, vary linearly with concentration down to zero concentration, whereas Pedersen[4] has shown that, in the case of lactoglobulin, the variation becomes very small at concentrations less than 1 gm./100 ml., and this finding has been confirmed recently[5]. There is no evidence that lactoglobulin dissociates under these conditions.

(3) The explanation offered does not account for the fact[2] that a protein which sediments through a solution of a less rapidly sedimenting protein (that is, the faster component of a mixture) does so at the same rate as it would do in the same total concentration of itself alone: the counterflow must be less in the former case than in the latter (cf. paragraph 1).

(4) No account is taken of the proximity of the sedimenting particles to each other; they are treated as though each were sedimenting against the counterflow of a uniform medium of infinite extent. The effect of the proximity of neighbouring particles on their viscous movement must be an important one, though it appears that no satisfactory quantitative treatment can be given at the present time.

Enoksson further maintained that the counterflow effect can account for apparent deficiencies of the amount of a sedimenting protein, as computed from the sedimentation diagram. No deficiency is, in fact, found, provided that the solvent which is displaced is in Donnan equilibrium (which will normally be the case) and that the value used for the specific refractive increment of the protein is obtained by measurement against dialysate. Any deficiency is likely to be due to use of a wrong value for the specific refractive increment and to errors affecting the baseline of the sedimentation diagram[6].

Finally, we should point out that our account[2] of the boundary anomaly is independent of any particular assumption about the cause of variation of sedimentation-rate with concentration.

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Dec. 16.

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A TECHNIQUE FOR THE CONTROLLED GROWTH OF EXCISED PLANT TISSUE IN LIQUID MEDIA UNDER ASEPTIC CONDITIONS

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EXCISED plant tissues are commonly grown on semi-solid rather than liquid media. Immersion of the cultures in liquid media usually reduces the rate of growth (a result presumably of reduced oxygen supply), while an effect on the ability of a culture to organise has been reported[1]. Given an inherent capacity of a tissue to grow, it is apparent that the growth-rate on an agar medium may well be limited by the rate of diffusion of nutrients through the agar. Hence the growth of such cultures may be more rapid on a liquid medium which is continually mixed, provided that access to oxygen is adequate. Growth in liquid media has obvious advantages wherever quantitative experiments on the absorption or nutritive effect of specific solutes is in question. It will be shown that for certain types of culture the liquid medium produces greater and more uniform growth.

DeRopp[2] has described an apparatus using liquid media for growth of excised plant tissues. In this technique the cultures were to be alternately bathed in the nutrient medium, then drained and exposed to air; but no growth-data from the use of this apparatus have been reported. Moreover, the technique appears rather unwieldy and hence is adaptable only to a relatively small number of cultures.

In the University of Rochester other methods have been devised. The method reported here has been found to be most satisfactory and instructive for the growth of excised plant tissue cultures, and is now described because it may be useful to other workers and may find further application in other biological fields.

In brief, the method makes use of a new type of culture tube: the tubes are mounted on disks which are slowly revolved about a horizontal shaft so that each tube is tumbled end over end.

The culture tube (Fig. 1*A*) is made from 'Pyrex' glass tubing sealed and rounded at each end. At the middle of each tube is a side neck through which the transfer of cultures can be made and, when plugged with cotton, through which gas exchange can occur. The culture tubes are mounted near the periphery of a circular disk of plywood so that the long axis of each tube lies along a radius of the disk and the side neck is parallel to the shaft (Fig. 1*B*). Twenty-four tubes (35 mm. in diameter and 125 mm. long) can be fastened to each disk, and many disks may in turn be fastened to a single shaft: for example, eight disks, accommodating 192 tubes, can be mounted on a shaft 40 in. long. The shaft is driven by a motor and is geared to 1 r.p.m. In this Department the entire shaft is mounted in a cabinet in which constant temperature, humidity and light may be maintained. The revolving klinostat equalizes gravitational stimuli and ensures that all the cultures are subjected to the same environmental conditions.

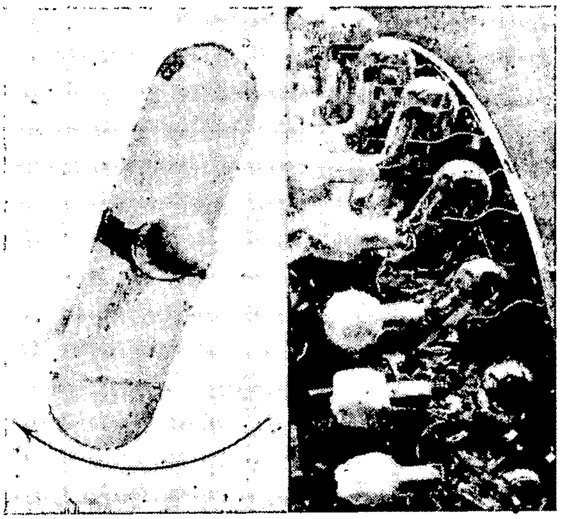

Fig. 1

As a tube 'tumbles' on the rotating klinostat the wet piece of tissue adheres at one end of the tube (Fig. 1*A*), whereas the liquid moves slowly from one end of the tube to the other, and as it does so, gaseous exchange with the outside air is maintained. It will readily be appreciated that with a constant volume of nutrient the fraction of the total time in which the tissue is immersed varies with the proportions of the tube; also with a tube of fixed dimensions the period in air decreases as the volume of nutrient is increased. For any given tube an upper limit to the volume of solution is set when the liquid, flowing along the now horizontal tube, tends to wet the plug. Somewhat larger volumes may be used if the axis of the klinostat is inclined to the horizontal. With these factors in mind, the dimensions of the tube have been fixed as indicated above. Ten ml. of a nutrient medium in a tube is convenient when maximal time in air is desired and also when such factors as the length of growing period for which nutrient must be furnished are taken into account.

In a previous note[3] it was shown that uniform 4-mgm. cylinders cut from carrot root will grow at rates far exceeding those previously described if coconut milk is added to the nutrient agar medium. In the present experiments carrot cultures were grown both in test tubes on agar and in liquid medium on the revolving klinostat described. All the cultures were exposed to the same external conditions and were exposed to the continuous light of a bank of fluorescent lamps. The cultures in the klinostat tubes were grown on a basal nutrient medium[4] to which was added 15 per cent by volume of coconut milk. For the cultures grown in test-tubes 0·8 per cent agar was added to the nutrient medium. All the explants were obtained from carrot cylinders, removed by a cannula, and cut with a multi-bladed cutter into 4-mgm. radial cylinders. Only phlœm cylinders with their inner tangential surface 1 mm. from the cambium were used. This technique and its implications will be described elsewhere.

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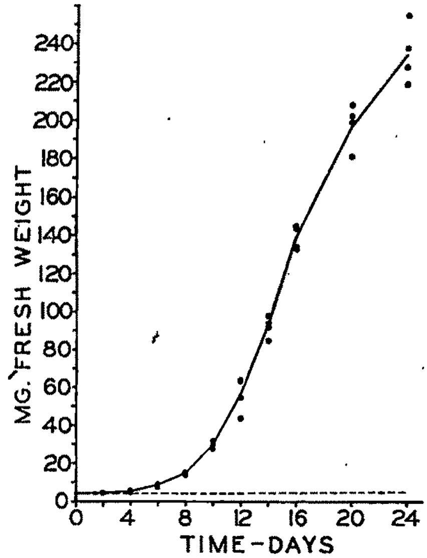

Fig. 2

In a given experiment, cultures grown in the klinostat tubes were not only larger and more uniform but also, under the standardized conditions of the klinostat, the growth-rates of carrot cultures are much more reproducible than when the cultures are grown in nutrient agar in the test tubes.

Fig. 2 shows a growth-curve of cultures of carrot initially 4 mgm. in weight. At each period four replicate cultures were weighed, and the curve is compiled from their means. There is evidently a lag of about four days followed by a very rapid growth reaching a compound-interest rate of increase in twelve days of 34·1 per cent per day. After some days a gradual decrease in the growth-rate occurs. This decrease is probably due in part to depletion of nutrients in the culture medium. (Changing the culture solution after some fourteen days does increase the growth.)

Single cultures readily grow from a 4-mgm. explant to about 175 mgm. before they become so large that they do not readily adhere to the glass, and so fall as the tube rotates. The amount of tissue grown in a given tube and medium may be increased by using more explants per tube, but this markedly reduces the size of each cultured explant. For the most part, the technique has been applied to cultures freshly excised from the carrot root. The rates of growth of subcultures tend to be more variable, probably because they cannot readily be cut into pieces of uniform size and shape which contain identical proportions of active cells.

Cultures grown in liquid media in klinostat tubes and on agar differ in form: the former become compact spheroids, especially when grown in the light, while those on agar become much more succulent and irregularly concave to the medium. In the dark, cultures in klinostat tubes become friable and tend to fall apart. These differences are being investigated and will be reported elsewhere. In the dark, carrot phlœm cultures change from deep orange to pale. In the light they become pale green. Cultures from certain carrots in the light have, however, been observed to become unpredictably coloured with a red pigment in the surface layers of cells. This does not, however, affect the conclusions on the efficacy of the technique here described.

Clearly this technique is applicable to the growth of other materials in liquid media. The growth of *Chlorella vulgaris* in the klinostat tubes was found to compare very favourably with growth under other conditions in liquid media as used by other workers. Ten ml. of the basal culture solution, in equilibrium with the carbon dioxide of the air, inoculated to contain 75 cells per mm.^{3}, produced in 7 days at 25° C. 57,000 cells per mm.^{3} at a light intensity of 240 foot-candles. The technique may well find application in the experimental growth of fungi for antibiotic studies, growth studies of yeast, etc. It has, however, proved its use in quantitative investigations on the growth of plant tissue cultures.

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EQUILIBRIUM BETWEEN METHYL-ACENES AND METHYLENE-DIHYDROACENES

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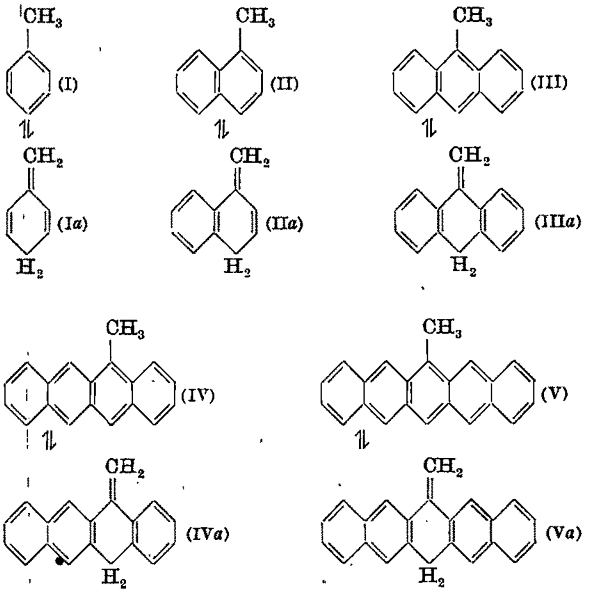
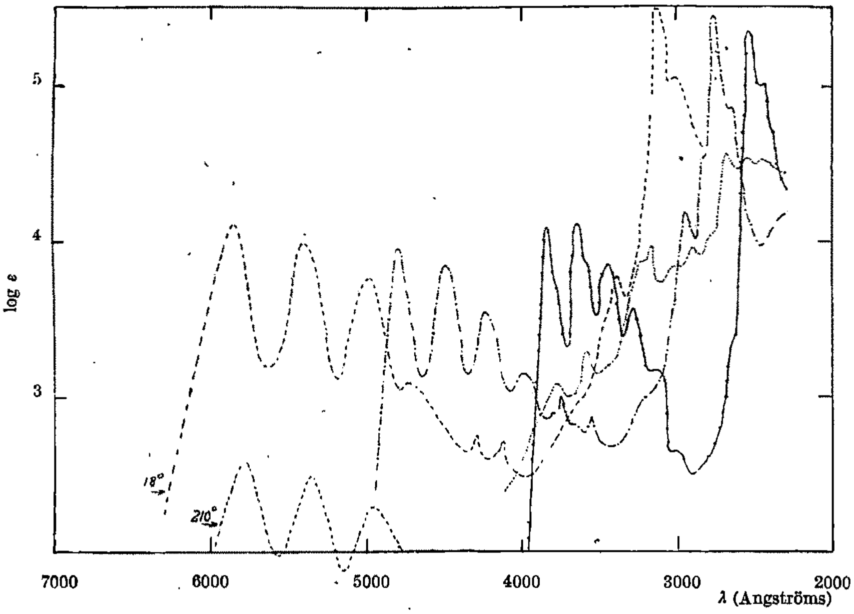
TAUTOMERISM between methyl-acenes (I, II, III, IV, V) and methylene-dihydroacenes (I*a*, II*a*, III*a*, IV*a*, V*a*, respectively) has often been postulated to explain side-chain reactivity of aromatic compounds, but hitherto no methylene-dihydroacene has been isolated. This weakness in the hypothesis has now been removed by the synthesis of pure 6-methylene-6 : 13-dihydropentacene (V*a*). The 'anellation principle'[1] requires a gradual transition in properties in the acene series, and it may be inferred, therefore, that (IV), (III), (II) and (I) will also contain the corresponding methylene forms, but in decreasing proportions.



* I.C.I. Research Fellow.



—•— —•—•—•—•—• Absorption spectrum of 9-methylanthracene in alcohol. Band maxima at: 3850, 3640, 3460, 3290, 3140, 3000; 2540, 2460 A.

—·—·—·—·—·— Absorption spectrum of 5-methyltetracene in alcohol. Band maxima at: 4805, 4490, 4220, 3980; 3750, 3560; 2950, 2755, 2650 A.

— — — — - — — Calculated absorption spectrum of 6-methylpentacene in 1-methylnaphthalene. Band maxima at: 5850, 5410, 5010; 4300, 4120; 3390, 3150 A.

-- — —— — — — (Lower curve.) Observed absorption of methylpentacene at 210° in 1-methylnaphthalene: 5790, 5360, 4960 A. (intensity qualitative); on rapid cooling the fading band maxima shift to: 5850, 5410, 5010 A.

------------------ Absorption spectrum of 6-methylene-6 : 13-dihydropentacene (V*a*) in alcohol. Band maxima: 3770, 3585, 3420; 3175, 3020, 2900; 2690, 2570 A.

This view is supported by study of the absorption spectra of the hydrocarbons (see accompanying graph). The spectrum of 9-methylanthracene (III) resembles very closely that of anthracene, but does not exclude the presence of a small proportion of the methylene form (III*a*), which would have only feeble absorption. The orange 5-methyltetracene (IV) shows an absorption similar to that of tetracene, but the intensity of the bands is considerably lower than in the case of tetracene, whereas with 9-methylanthracene and anthracene the reverse relationship holds. This suggests the presence in (IV) of an appreciable proportion of a weakly absorbing methylene form (IV*a*).

When we come to the pentacene series, we find that the spectrum of the pale yellow methylenedihydropentacene (V*a*) shows no resemblance to that to be expected for methylpentacene (V), which may be calculated by application of the anellation principle[1]. If the pale yellow solution of (V*a*) in 1-methylnaphthalene is heated with exclusion of air to 200°, the solution becomes violet-red and shows the first three bands calculated for methylpentacene (V). The colour fades slowly on cooling.

The fact that methylpentacene exists at room temperature almost entirely in the methylene form (V*a*) is important from the point of view of resonance in aromatic compounds. As each member of the pairs of structures formulated above contains the same number of double bonds as the other member, the energy-difference between the methyl form and the methylene form must consist of the difference in resonance energy. Wave mechanical treatment predicts a decreasing difference in resonance energy of these pairs of hydrocarbons with increasing numbers of rings, until the difference becomes zero with an infinite number of rings[2]. Hence the ratio between methylene and methyl forms should never exceed 1 : 1. This prediction has thus been shown to be entirely erroneous, and the evidence now adduced may perhaps provide a new basis for the calculation of the decreasing energy per ring in the higher acenes.

9-Methylanthracene (III) was prepared as described by Sieglitz and Marx[3]. 5-Methyltetracene (IV) was obtained by dehydration of the crude carbinol formed by interaction of methylmagnesium iodide with tetracenone, prepared by reduction of 5 : 12-tetracenequinone[4] with alkaline sodium hydrosulphite solution. It formed orange-red prisms (from benzene), m.p. 160°, and gave a bright green solution in sulphuric acid (found: C, 94·2; H, 5·7. $C_{19}H_{14}$ requires C, 94·2; H, 5·8 per cent).

6-Methylene-6 : 13-dihydropentacene (V*a*) was similarly prepared from pentacenone[5], and formed pale yellow needles (from xylene), which dissolved in sulphuric acid to give a blue solution which afterwards turned to brown (found: C, 94·4; H, 5·65. $C_{23}H_{16}$ requires C, 94·5; H, 5·5 per cent). The melting point was between 244° and 254°, and in an evacuated capillary the melt was deep red. Oxidation with selenium dioxide in boiling nitrobenzene gave pentacene-5 : 13-quinone. A sparingly soluble by-product from the Grignard condensation formed colourless crystals, m.p. 420° (decomp.), which gave a greenish-yellow solution in sulphuric acid (found: C, 94·2; H, 5·8. $C_{46}H_{32}$ requires C, 94·5; H, 5·5 per cent).

We thank the Department of Scientific and Industrial Research for a grant which enabled one of us (J. W. W.) to participate in the experimental section of this investigation.

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[1] Clar, E., "Aromatische Kohlenwasserstoffe", 20 (Springer-Verlag, 1941).

[2] Sirkin, J. K., and Diatkina, M. E., *Bull. Acad. Sci. U.R.S.S.*, Cl. Sci. Chim., 153 (1946). Brit. Abstr., AI, 365 (1946). The view of these authors was supported, and in some cases an even greater stability of the higher methyl-acenes was predicted in private communications from other workers.

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[4] Clar, E., *Ber.*, **75**, 1271 (1942). Compare Fieser, L. F., *J. Amer. Chem. Soc.*, **53**, 2329 (1931).

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USE OF GEIGER COUNTER FOR QUANTITATIVE ESTIMATION OF RADIOACTIVE ISOTOPES IN HISTOLOGICAL SECTIONS

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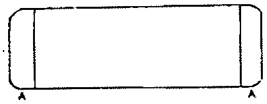
THE problem of obtaining quantitative estimation of radioactive isotopes in histological sections has been under investigation in this laboratory for the past year, and an attempt at its solution is described below.

A detachable, movable stage had soldered to its under-surface a ½-mm. sheet of copper in which a ½- or 1-mm. hole had been drilled. A microscope slide placed in the movable part of the stage could then be altered in position at will so that the whole of any section mounted on it could be 'scanned' by the hole. A lead 'castle' has been designed to take this movable stage and its slide. It consists of a circular shouldered base (5 in. high) which is hollow and contains a brass tube with a screw-on head in which the Geiger–Müller counting-chamber is mounted. The head has a ¾-in. diameter hole by which access is obtained to the window of the counting-chamber. On top of the shoulder fits a square lead tray with an eccentrically placed hole (4 in. diameter), through which the head of the base projects. On top of this tray fit three 1½-in. thick blocks of lead. The movable stage is placed in the tray with the 1-mm. hole in its copper shield directly above the window of the counting-chamber. The three blocks of lead are placed above the tray to reduce cosmic and other interference.

Fig. 4



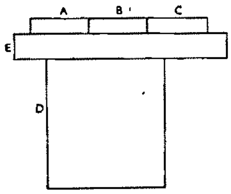
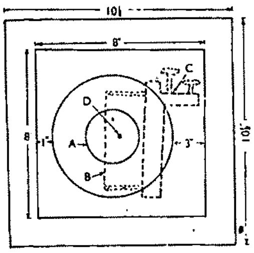


Fig. 1

Fig. 3



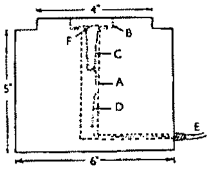


Fig. 2

Fig. 1. General elevation view of lead 'castle'. *A,B,C.* Slabs of 'lead' (see Fig. 4) covering top of castle. *D.* Base. *E.* Upper portion in which movable stage is placed

Fig. 2. Base of lead 'castle'. *A.* Brass tube. *B.* Metal cap holding Geiger–Müller counter in position. *C.* Geiger–Müller counter. *D.* Connexion from Geiger–Müller counter to exterior. *E.* Connexion from castle to power unit and scaler. *F.* Window of Geiger–Müller counter

Fig. 3. Tray for holding movable stage. *A.* Window of Geiger–Müller counter. *B.* ½-mm. copper sheeting underlying microscope slide and attached to movable stage. *C.* Movable stage. *D.* Scanning hole (varying from ½–1 mm.) in *B*

Fig. 4. One of three lead slabs for covering Fig. 3. *A.* Lifting flaps

The advantage of this movable stage is that it can be placed under a microscope and the piece of tissue from which one wishes to count moved directly over the hole in the copper sheet. A photograph can, in fact, be taken of each field of tissue, prior to counting, if desired. Tissues used for this purpose can be cut and mounted in the usual way on glass slides; but if a glass cover slip is used, the radiation from the section is reduced by at least one-half. 'Cellophane' cover-slips are therefore preferable. A 1-mm. scanning hole is about equal to the field seen under a low-power (⅔) objective of the microscope and, of course, covers a piece of tissue of appreciable diameter. Smaller holes can be obtained by piercing ½-mm. sheets of lead with a needle, and by this means holes equal to the size of a high-power (⅙) microscopic field can be obtained. These lead sheets can be stuck over the copper shield with cellulose acetate-tape, the smaller hole being superimposed on the 1-mm. hole in the copper. It is possible to obtain still smaller holes by this method, but it will have to be shown that the apparatus is sensitive enough to make smaller 'scanning' holes desirable.

Dalgaard[1] has also published on this subject, which he has approached in a similar but not identical fashion. He has described a method of obtaining quantitative estimates of alkaline phosphatase activity by allowing the enzyme to deposit radiophosphorus until there is enough activity for counts to be made. It is more difficult to apply this method for estimating activity in histological sections of tissues from animals which have been injected with radioactive isotopes. A few results which give an indication of the scope of the present technique are therefore appended.

A slide bearing a 10-μ section of thyroid but with no thyroid tissue over the scanning hole, and taken from a rat which had been injected with 24 microcuries of iodine-131 six hours before it was killed, was placed in the 'castle'. The background count was 12 per minute. The slide was then moved so that thyroid tissue was over the hole. Sections of about thirty follicles of various sizes could be seen. Ten counts of the same field varied between 26 per minute and 53 per minute, with an average of 39·8.

Pieces of thyroid from the same rat were then treated with hydrochloric acid and the follicles separated away from each other by needles under a dissecting microscope. The tissue was then covered by Apathy's mounting medium and dried. By placing this slide in the apparatus, it was possible to move the scanning hole so that it covered only a single whole follicle. The greater volume of thyroid tissue on this slide gave a higher background count of 71 per minute. Counts from four different follicles of approximately equal size were 143, 123, 153 and 134 counts per minute. It seems that with further refinement we may expect to obtain significant counts at a still lower microscopical level.

The method has also been applied to ground sections of lower jaws and femurs of rats which had been injected with radiophosphorus.

It appears that this technique would be of value for studying the distribution of radioactive isotopes in both adult and particularly embryological tissues.

I am greatly indebted to Mr. R. Oliver, of the Radiotherapy Department, London Hospital, and Mr. A. Love, of the E.R.D. Engineering Co., for most valuable assistance in the design and assembling of apparatus described herein.

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[1] Dalgaard, J. B., *Nature*, 162, 811 (1948).

SPECTROPHOTOMETRIC EQUIPMENT

THE forty-fifth science meeting of the Colour Group of the Physical Society was held on March 30 at the Royal Photographic Society, 16 Prince's Gate, South Kensington, S.W.7, to discuss "Photo-electric Spectrophotometers and Tricolorimeters". The meeting was arranged to explain the difficulties that may be encountered by those contemplating work with these instruments, and to compare the different methods of measurement. Dr. W. S. Stiles was in the chair, and about ninety people were present.

The discussion was opened by Dr. T. Vickerstaff (Imperial Chemical Industries, Ltd.), who had recently been in the United States, and who described American instruments. He said that most research associations there seemed to possess a Hardy recording spectrophotometer and that each owner appears to have done something to improve it. Improvements included those to lengthen the life of the lamp, to overcome difficulties due to polarized light, to reduce scattered light, to improve the efficiency of the sphere-photo-electric cell unit, and to facilitate fitting the paper accurately on the drum. A new design is being made in which a linear wave-length scale is provided both for the visible and near infra-red ranges.

Another widely used and generally approved instrument is the Cary recording spectrophotometer, with an operational wave-length range from 0·21 μ to 0·6 μ and marked ranges from 0·2 μ to 0·35 μ and 0·3 μ to 0·8 μ. The slit widths at which this instrument operates are exceedingly small, about 0·0002 μ. This is a welcomed improvement on the Hardy instrument, in which the sum of the slit widths is 0·02 μ. The Snow-Duplex cathode ray spectrophotometer was seen, but an opinion on its performance was not possible owing to the conditions prevailing at the time. The non-recording Beckman is widely used, and a cheaper model with a direct-reading meter is being marketed.

Three calculators to give C.I.E. chromaticity co-ordinates from the spectral transmission curves were seen. One at the General Aniline Company was coupled directly to the Hardy spectrophotometer and evaluated the summations during the recording. An accuracy of 0·0005 was claimed.

The photo-electric tricolorimeters seen were the Hunter reflectometer and the P.P.G.I.D.L. colour eye. Both these instruments used photo-electric cells with filters to obtain the required C.I.E. distribution curve sensitivity.

General requirements for spectrophotometry were indicated by Mr. H. G. W. Harding (National Physical Laboratory). He said that direct-current light sources are desirable so that sectors can be used. Double monochromators are necessary, and the wave-length control should focus the optical system and alter the slit widths so that a fixed wave-band can be chosen throughout the spectrum. Some of the slits should be curved, and the exit slit should be straight for thermopile work. Some routine measurements require detectors to measure energy ratios of 10^8 to 1, and although it is preferable that the photo-electric cells should act only as out-of-balance detectors, the linearity of their response has to be relied on for such measurements. Reflexion measurements for colorimetry should be made under C.I.E. conditions, and annular cathode photo-electric cells would facilitate this. Completed instruments should be tested separately for wave-length calibration by line sources, and for linearity by neutral glass filters. Automatic instruments that would deal with large specimens are desirable; those now available are very valuable, but they are not as accurate as manually operated instruments, neither will they measure very low transmissions.

Dr. A. Sommer (E.M.I. Research Laboratories) explained how different parts of the spectrum range between 0·2 μ and 1·3 μ can be detected by antimony–cæsium cathodes in quartz or glass envelopes, bismuth–silver–cæsium cathodes and silver–oxygen–cæsium cathodes. Gas-filled cells are unsuitable for precision measurements, he said, and the vacuum types are generally used. Multiplier cells are useful for very low illuminations and for light signals of high frequency. Antimony–cæsium multiplier cells are made with multiplication factors of the order of 10^8. Two types of antimony–cæsium multiplier cell are made in Great Britain, one in which the light passes through the bulb to the cathode on the opposite side (thick-layer type), and another in which the semi-transparent photocathode is deposited directly on the inside of a flat entrance window. The latter type has an improved red sensitivity and reduced blue sensitivity compared with the former, and it has the advantage that a luminous surface can be held within a few millimetres of the cathode. Quartz windows are to be fitted to these cells.

Particular needs for spectrophotometry were outlined by Mr. J. R. Stansfield (Hilger and Watts, Ltd.). He said that hydrogen lamps with a current stability of 1 part in 20,000 give a radiation output constant to better than 0·05 per cent, and tungsten filament lamps can give similar stability, although greater care is necessary in controlling the power supplies. The variations in Nernst filaments and glow-bars for infra-red radiation make double-beam spectrophotometry desirable.

The elimination of stray light should receive particular attention, and although double monochromators are necessary for some work, single monochromators are adequate for many purposes, as some can give a stray light intensity of less than 0·1 per cent of the pure radiation intensity. Double-beam spectrophotometry eliminates errors due to fluctuations in the source of radiation; but as exact equality of two monochromators is difficult to obtain, the practice of passing the two beams alternately through one monochromator is now being adopted. The photo-electric cells of the detectors should, where possible, be used only as indicators of inequalities between successive beams of light. More multiplier cells should be made available, especially ultra-violet sensitive ones, and there is a need for accurate high-speed recorders.

Mr. G. T. Winch (General Electric Co., Ltd.) was unfortunately not able to address the meeting. His contribution was read by Mr. R. G. Horner, and Miss B. M. Young answered questions about it. A description was given of the dispersion and mask method, in which a spectrum is formed and a mask used in the plane of the spectrum to limit the transmission of light of each wave-length. The method is theoretically perfect; but many precautions are necessary if the accuracy of visual methods, namely, 0·01–0·02 in the chromaticity co-ordinates for a 2°-field, or 0·001–0·004 for a 15°-field, are to be obtained without resource to substitution methods. The requirements have been met by temperature control of the photo-electric cell, which is linear to a few parts in 10,000 for a 10 to 1 light ratio, having grid leak values up to 10^{12} ohms in a D.C. amplifier giving a limiting sensitivity of about 10^{-11} lumen to get adequate sensitivity, obtaining a spectral resolution of about 0·0003 μ in a 30-mm. spectrum and by producing masks by the Kodak etch-bleach process. The $\bar{x}$, $\bar{y}$, $\bar{z}$ and spectrum band masks are mounted on a wheel, and a blue temperature-conversion filter is used to compensate for the yellowing of sphere paint when it is part of the instrument.

A general discussion followed, and many aspects of spectrophotometry and colorimetry were considered. At the end of the discussion it seemed that the fully automatic recording spectrophotometers for ultraviolet and visible radiation made in the United States are giving good service, and that the photo-electric colorimeters developed in Great Britain are likely to give the same to colorimetry. It was pointed out that annular cathode photo-electric cells have been made n Britain.

The meeting was closed by a description and demonstration of the new Hilger Uvispek photoelectric spectrophotometer. This manually operated instrument, which covers the wave-length range from 0·21 μ to 1·0 μ, should be of great value in the field of spectrophotometry. H. G. W. Harding

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AUTOMATIC CONTROL-SYSTEM TERMINOLOGY

At the request of the Ministry of Supply, the British Standards Institution is preparing a "Glossary of Terms used in Automatic Controlling and Regulating Systems". This is divided into four Sections, the second of which, on "Process Control"*, has been published recently; Section 3, which is in preparation, will cover the nomenclature of position control, and Section 4 will deal with automatic regulators; Section 1, which is to contain the terms common to all closed-loop servo systems, will be prepared when the other three have been completed. Every definition is given a four-digit reference number, indicating its section, subsection and position therein.

Section 2 is a welcome publication, representing the first serious attempt which has been made in Great Britain to bring some semblance of order into a field where chaos has reigned supreme. The existing confusion is due partly to historical accident, for the three main divisions of control engineering were developed separately by groups having little contact with each other. For example, the designers of engine-speed governors, of thermostats and of military fire-control equipment failed to appreciate in the early stages that they were all concerned fundamentally with the same problem: namely, that of increasing the accuracy of performance of their equipment, under ever more stringent conditions of load and disturbance, while maintaining an acceptable standard of stability in the system as a whole. It was due to this lack of contact that three separate systems of nomenclature are now current; not only is the same phenomenon referred to by several different names, but also, even worse, the same word is often used by different engineers to indicate quite distinct phenomena.

The aura of mystery which surrounds the whole subject of automatic control in the minds of many engineers can be attributed largely to its illogical and unscientific terminology. In fact, the situation is even more chaotic than that stated above, for there is a considerable variety of usage even among the workers in a single field; a most valuable purpose will be served by the new glossary if it does no more than standardize the practice within each of the three separate fields, and it is to be hoped, therefore, that every control engineer will adhere to the recommended usage.

The glossary could be of more fundamental importance if it also helped to introduce a greater degree of uniformity between the separate fields of control. It is difficult, with only one part now available, to judge to what extent it will do this; but the task is undoubtedly a difficult one, for the technical differences between the fields are in some respects considerable, though by no means as great as is generally believed. It is regrettable, perhaps, from this point of view that it has been found necessary to separate the glossary into sections, for this will tend to emphasize a distinction which is in many instances more apparent than real.

As an example, consider the word 'offset' (definition 2203); in position control practice this is called the 'steady state error'. Is the latter term to be scrapped, or are we to have two names for the same thing? Again, is it impossible to persuade process control engineers to use the terms 'input', 'output' and 'error', in place of 'desired value', 'controlled condition' and 'deviation'? The former sound scientific, the latter sound amateur. The sign of the deviation is defined differently from what is customary for *position* control in Great Britain and in the United States. The Americans are unlikely to alter their practice, so that this will perpetuate the present ridiculous anomaly of having two contradictory definitions in use simultaneously; for it is a sad fact that the only books on control engineering come at present from the United States.

The intention is to review the present standard in a year, and suggestions for improvement are requested. The following comments may therefore be of some value. Terms for 'input element' and 'difference element' are not defined; they might be combined to form an 'input unit'. 'Measuring unit' (2106) is defined in terms of 'measuring element', which is listed among those terms the use of which is deprecated; this emphasizes the point that it is, in fact, necessary. 'Floating control' is not mentioned as a synonym for 'integral action'; it should at least be given, if only to deprecate this common usage. 'Proportional band' (2502) has another meaning, different from that given, namely, "the range within which controller action is linearly related to deviation"; if its use in this sense is deprecated, some alternative should be provided. Finally, the term 'two-step action' (2408) is an unsatisfactory alternative to 'two-position action' (deprecated), since such a control has only one step, though it has two positions.

It would, of course, be possible to make other minor criticisms; but these do not detract from the entirely admirable intention behind this glossary and the treatment which, so far as one can judge at present, maintains the high traditions of the British Standards Institution. R. H. Macmillan

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* British Standard No. 1523:1949. Glossary of Terms used in Automatic Controlling and Regulating Systems. Section 2: Process Control. Pp. 21. (British Standards Institution, 24/28 Victoria Street, London, S.W.1.) 2s. 6d.

GENETICS OF DIŒCY AND MONŒCY IN *ECBALLIUM*

DIŒCY, the separation of the sexes on to different diploid individuals, occurs irregularly throughout the higher plants. It must therefore have arisen a number of times during the evolution of this group. Thus the genetical control of diœcy is of considerable interest, particularly in regard to the differences between diœcious forms and their monœcious or hermaphroditic relatives. Little information has been available about such differences in the past; but two mimeographed papers[1,2] have now been circulated, in which Dr. F. Galán, of the University of Salamanca, describes the results of crosses between diœcious and monœcious forms of the cucurbitous plant *Ecballium elaterium*.

The monœcious form occurs in the northern half of Spain and the diœcious form in the southern half. The two appear to be readily crossed in both directions. The hybrids are fertile and various F_2 and back-cross progenies were raised. These indicated that monœcy is determined by a third allelomorph at the locus, the other two allelomorphs of which operate the normal sex mechanism in the diœcious form. Thus the monœcious form is (in Galán's notation) $a^+ a^+$, while in the diœcious types males and females are $a^D a^d$ and $a^d a^d$ respectively. The allelomorph a^+ seems to be recessive to a^D but dominant to a^d.

A few plants occur which are unexpected in this scheme. It seems that they are individuals which should be monœcious, carrying both types of flower; but actually bear flowers of only one sexual type. The experiments could not easily have revealed whether there occurred opposite types of aberration, genetically male or female plants bearing both sexual types of flower. No information is therefore available on this point.

About 1 per cent of the plants which presumably are genetically monœcious in Galán's scheme appear as females in the F_1. These must, however, be $a^+ a^d$, so that we may suppose the dominance of a^+ over a^d not to be unconditional. In F_2 and back-crosses, aberrant types appear which cannot be explained so simply. Thus monœcious F_1 plants, which must be $a^+ a^d$, give occasional males, as well as the monœcious and female plants expected, on selfing. We must suppose these males to be genetically $a^+ a^+$ or, less likely perhaps, $a^+ a^d$. In back-crosses, plants which must be $a^+ a^+$ sometimes appear as females. The frequencies of these aberrant phenotypes are about ½ per cent in the back-crosses and nearly 7 per cent in F_2.

The author records that a plant which appears as male or female in its first year of flowering may carry both types of flower in later years, the chance of this occurring being itself genetically controlled. The F_1 was classified as second-year plants, but the F_2 as firsts. Thus the frequencies of aberrant phenotypes in these latter generations may be somewhat overestimated. This over-estimation is, however, unlikely to be great, as only ½ per cent of the back-cross plants seem to be aberrant.

It would thus appear that in addition to their allelomorphs at the main, *a*, locus, the two forms differ in their genetic backgrounds. The diœcious form contains genes, doubtless members of a polygenic system, which, when introduced by crossing into a plant monœcious in respect of the *a* locus, upset its development so that it digresses towards one sex or the other. It is not clear whether the background genotype of the F_1 would ever cause such an upset in $a^+ a^+$ plants; but it does seem clear that, even if it did, the upset would be rarer than is observed in F_2. In other words, the F_1 is heterozygous for the differences in genetic background, and these differences segregate in F_2. Some 7 per cent of the segregant backgrounds are unbalanced in the sense that they divert the normal monœcious development. The disturbing effect of segregation should be less in back-crosses, as indeed the lower frequency of aberration shows it to be.

Thus the evolutionary divergence of the monœcious and diœcious forms seems to have followed the genetic pattern familiar to us from other mechanisms controlling the breeding system. A difference has developed at a main locus, the segregation of which operates the diœcious system. But at the same time the genetic background of each form has been adjusted, in its own special way, to give just those types which the main gene immediately determines. On this basis we can further see how populations could show a gradual transition between monœcy and diœcy through a state consisting of a mixture of the two. It is to be hoped that the author will continue his experiments and establish the genetical interpretation more firmly by further investigation of aberrant individuals and mixed populations in later generations of selected lines.

Dr. Galán has also published an extensive review[3] of the various genetical theories of sex determination in animals and plants; but this is written in Spanish.

K. MATHER

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[1] "Analysis of the Genetic Differences between the Monœcia and Diœcia Zygotes in *Ecballium elaterium*."

[2] "Analyse génétique de la monœcie et de la diœcie zygotiques et leur différence dans *Ecballium elaterivm* (Cucurb)."

[3] "Exposision y critica de las Teorias de la Determinacion del Sexo" (Salamanca, 1942).

SOIL CONSERVATION IN BRITISH COLONIES

THE serious nature of the problem of soil erosion in many parts of the British Colonial Empire has been realized for some time, and in recent years much has been done to extend conservation measures. Considerable experience has accumulated since the position was last reviewed in 1944; but the more recent information has remained scattered, and in 1946, with the approval of the Secretary of State for the Colonies, a questionnaire was sent to the directors of agriculture in dependencies where soil conservation had made good progress. The information received, supplemented by data from published papers and reports, has been collected together by Sir Harold A. Tempany and issued by the Commonwealth Bureau of Soil Science, Harpenden, as Technical Communication No. 45, "The Practice of Soil Conservation in the British Colonial Empire" (Aberystwyth: Commonwealth Agricultural Bureaux, 1949. 10*s*.).

Factors affecting the incidence of erosion and its occurrence under different types of cultivation are discussed, and various forms of soil conservation described. Two main methods are recognized, one dependent on the use of earth structure, the other based on the use of cultural practices and living plant material. It is emphasized that soil conservation should not be regarded as a separate end, but rather ntegrated into systems of husbandry capable of maintaining and enhancing fertility. Besides discussing the problem from the agricultural point of view, attention is also directed to the dangers of erosion around buildings, during construction of roads and in mining areas.

In order that measures for soil conservation shall be fully effective, communal action is called for, which may involve drastic modification in land utilization and agricultural practices. Some kind of legislation is therefore necessary. At present, the provisions for this vary widely in the different dependencies. In some it is built on the American model, whereas in others it is of a simpler form, or even based on the local rules of tribal or native authorities. A number of these provisions are described, those in operation in America being included for comparison.

CARE OF FISH IN TRAWLERS

THE importance of fish, a home-produced protein food, cannot be overstressed. To ensure that such a valuable but highly perishable food reaches the consumer as fresh and palatable as possible, care must be taken in its treatment on board the fishing vessel as well as after landing.

A new edition of "Food Investigation Leaflet No. 3, The Care of the Trawler's Fish" has recently been published for the Department of Scientific and Industrial Research by H.M. Stationery Office, price 4*d*. It is intended to help owners, skippers, mates and crews of trawlers and other vessels that catch 'white' fish to land their catches in the best possible condition. The leaflet, which has been revised and considerably extended, is concerned with the general practice of stowage in crushed ice.

The first section explains broadly and simply the scientific basis upon which the practical recommendations rest. Sea-water bacteria are the main agents of spoilage, bringing about the more striking undesirable changes in odour, flavour and appearance. These bacteria, simple types and harmless to man, are present in very considerable numbers on the outer surfaces, including the gills, of the gutted and washed, freshly caught fish, but not in the flesh. At ordinary temperatures, however, these bacteria multiply rapidly and invade the flesh, producing substances responsible for the stale, and later the putrid, odours and flavours associated with spoiling and spoiled fish, while the external surfaces become covered with dirty-coloured slime and lose their fresh bloom.

Practical recommendations are discussed in the second section. Chilling by stowage in crushed ice, although greatly retarding the activity of the bacteria, and hence spoilage, of the fish, does not stop it. Nevertheless, chilling is the most effective single factor in keeping fish fresh, and the greatest possible care should be taken to see that enough ice is used to chill the fish thoroughly and to keep it chilled until landing. In addition to controlling temperature, it is highly important to gut and wash the fish properly and to handle and stow it with care as soon as possible after catching, avoiding bruising, tearing or crushing. These principles hold good for all voyages, whether of a few days or of three weeks or even longer, as is now customary in the case of the distant-water vessels which provide more than half the fish supplies of Britain. The more fully they are observed, the better will be the general quality and acceptability of the fish.

A new feature of the leaflet is three appendixes. The first outlines the more important characteristics in the odour, appearance, texture, etc., of fresh and spoiled 'white' fish in both raw and cooked states. The second shows diagrammatically how, during stowage in ice for periods up to three weeks, the changing condition of the fish, as normally observed by the senses, is accompanied by increase in bacterial infection and in undesirable chemical changes in the flesh of the fish. The third appendix is a specimen short code of practice that might, it is suggested, be kept continuously before all concerned with the care of the fish.

The preservation of pelagic fish—namely, herring, pilchards and mackerel—is not dealt with in the pamphlet. So far as herring and pilchard are concerned, the problem of preservation scarcely arises on board, as the normal practice is to land the fish a few hours after they are caught. This, however, does not apply to the chief British mackerel fishery, in which the fish are often preserved on board in crushed ice for several days. In a highly perishable fish such as mackerel, great deterioration often takes place in a very short time. It would therefore seem worth while devoting some effort to devising for these fish, too, better methods of preservation on board and in land transit than are generally practised at present.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, June 13

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

Monday, June 13—Tuesday, June 14

INSTITUTION OF GAS ENGINEERS (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—86th Annual General Meeting.

Tuesday, June 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Wednesday, June 15

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 4 p.m.—Dr. H. J. Plenderleith: "The History of Artists' Pigments".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.*

Wednesday, June 15—Friday, June 17

INTERNATIONAL GAS UNION (at the Institution of Civil Engineers, Great George Street, London, S.W.1)—Fourth International Gas Conference.

Thursday, June 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Practical Postgraduate Training of Mining Engineers".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. D. R. Hartree, F.R.S.: "Some Unsolved Problems of Numerical Analysis".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting; Dr. R. V. Talice (Montevideo) will show a film dealing with Chagas' Disease.

Friday, June 17

BIOCHEMICAL SOCIETY (in the Department of Chemistry, The University, Nottingham), at 2 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Discussion on "Astronomical Navigation in the Air".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Director of Research in the Department of the Chief Development and Research Officer—The Chief Staff and Welfare Officer (Ref. F/EV.85), London Transport Executive, 55 Broadway, London, S.W.1 (June 17).

Lecturer in Biology—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (June 18).

Teacher in the Science Department, Northampton College of Technology—The Chief Education Officer, County Borough Education Committee, Springfield, Cliftonville, Northampton (June 18).

Assistant Physicist to the Hospital and to the Radiotherapy Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, endorsed 'Physicist' (June 18).

Senior Assistant, and a Lecturer with special responsibility, in the Department of Chemistry, and a Lecturer in Mathematics—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (June 18).

Lecturer in Physics, for classes from Intermediate to B.Sc. Special standard—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (June 18).

Assistant Lecturer (Grade III) in Geography—The Secretary, The University, Birmingham 3 (June 18).

Physicists and Civil Engineers at a Ministry of Supply Research Establishment in Essex, to study effect of explosives on concrete buildings and structures—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.138/49A (June 25).

Assistant Lecturers (2) in the Department of Organic Chemistry—The Registrar, The University, Liverpool (June 25).

Lecturer or Assistant Lecturer in the Department of Biochemistry—The Registrar, The University, Sheffield (June 25).

Pomologists (2), a Plant Physiologist, a Chemist in Domestic Fruit and Vegetable Preservation Section, a Chemist in Cider Section, a Microbiologist in Cider Section, and a Willow Officer for research and advisory duties, in the Department of Agriculture and Horticulture, Long Ashton—The Secretary and Registrar, The University, Bristol (June 27).

Lecturer in Pathology in the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

Principal of the Polytechnic—The Clerk to the Governing Body, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 30).

Technician for the Clinical Department of the Medical School—The Dean's Office, School of Medicine, The University, Leeds 2 (June 30).

Demonstrator in Geography—The Secretary, University of Durham, 38 North Bailey, Durham (June 30).

Lecturer in Mathematics in University College, Dundee—The Secretary, The University, St. Andrews (June 30).

Scientific Officers (4) for the Soil Survey of Scotland, a Scientific Officer for studies in Plant Physiology, a Scientific Officer for Radioactive studies, a Scientific Officer in the Department of Soil Fertility, and an Experimental Officer as an Analyst in the Department of Soil Fertility—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (June 30).

University Demonstrators in Agriculture, Soil Science, Agricultural Botany, Agricultural Mycology, Agricultural Entomology, and an Assistant in Research in Agricultural Economics—The Secretary, School of Agriculture, Cambridge (June 30).

Senior Research Officer-Chemist, and a Research Officer-Chemist, in the Paint Industries Research Institute (University of Natal), Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

Research Demonstrator in Botany and Zoology—The Registrar, University College, Singleton Park, Swansea (July 2).

Lecturer in Civil Engineering, and an Assistant Lecturer in Mathematics—The Registrar, The University, Leeds 2 (July 9).

Research Soil Chemist—The Secretary and Registrar, University College of North Wales, Bangor (July 9).

Assistant Lecturer or Lecturer in Physics—The Registrar, The University, Leeds 2 (July 9).

Senior Lecturer in Physics, specializing in Nuclear Physics, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Auckland, July 15).

Senior Lecturer in Electrical Engineering (Power and/or Machines) in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 15).

Lecturers (2) in the Department of Meteorology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (July 15).

Mathematical Assistant (Lecturer or Assistant Lecturer grade) for work in connexion with the Automatic High Speed Computing Machine—The Registrar, The University, Manchester 13 (July 20).

Assistant Lecturers (2) in Engineering—The Registrar, The University, Manchester 13 (July 21).

Lecturer in Forestry—The Secretary, The University, Aberdeen (July 21).

Professor of Botany at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 30).

I.C.I. Fellowship for research in Chemistry or Physics (or a related subject), tenable at Durham or Newcastle—The Registrar, University Office, 46 North Bailey, Durham (July 30).

Senior Lecturer in Mechanical Engineering in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

Technician in the Department of Bacteriology—The Supe intendent, Royal Infirmary, Sheffield 6.

Senior Assistant in Physics—The Principal, Derby Technica College, Normanton Road, Derby.

Extension Lecturer (with a good honours degree and qualifie to teach Natural Science, particularly Biology)—The Secretary, Oxfor University Delegacy for Extra Mural Studies, 7 Wellington Squar Oxford.

Graduate Research Worker in the Electron Microscope Labora tory—The Director, National Institute for Medical Researc Hampstead, London, N.W.3.

Chemist to take charge of research work (at present being carrie out in the Department of Textile Industries, Leeds University)—The Secretary, British Brush Manufacturers' Research Associatio Ltd., 80 Coleman Street, London, E.C.2.

Lecturer in the Department of Physics, and a Senior Assistan in charge of Biology—The Principal, Technical College, Queen Stree South, Huddersfield.

Physicist in the Radiotherapy Centre—The Secretary to th United Leeds Hospitals, General Infirmary, Leeds.

Assistant Lecturer and Demonstrator in Bacteriology—Th Secretary, King's College of Household and Social Science, Campde Hill Road, London, W.8.

Junior Assistant Physicist—The Secretary, Bristol Roy Hospital, Guinea Street, Bristol 1.

Biochemist (non-medical)—The Director of the Pathologic Laboratory, Coventry and Warwickshire Hospital, Coventry.

Assistant Professor of Biochemistry—The Dean of Medicin University of Alberta, Edmonton, Canada.

Research Scholarships (2)—The Principal, Technical Colleg Bradford.

Research Fellowships (2) in Physics—Dr. G. M. Shrum, Hea of the Department of Physics, University of British Columbia, Van couver, B.C., Canada.

Lecturer in Rubber Technology—The Clerk, National Colleg of Rubber Technology, Northern Polytechnic, Holloway Road London, N.7.

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THE UNIVERSITY IN MODERN SOCIETY

SIR WALTER MOBERLY has had a life-long experience of British universities and their problems, derived as a tutor at Oxford, as vice-chancellor of a great civic university, and since 1935 as chairman of the University Grants Committee. Among these problems he moves with the ease of long intimacy and deep understanding, and in his recent book* he writes with a charm and persuasiveness that match the penetration and balance of his thought. Sir Walter, indeed, disclaims some of the credit for the book, attributing it in part to a conference of between thirty and forty university teachers of Christian outlook held at Cambridge in September 1946, where discussion centred largely on a series of "University Pamphlets" published by the Student Christian Movement Press (see *Nature*, 159, 392; 1947). If, however, to some extent the book does express the converging thoughts of those and of many other minds, its value is derived none the less largely from the quality of Sir Walter's own thought and the lucidity of his prose. It is an outstanding British contribution to constructive thought about the future of the universities, and should be read by all those who have studied the latest report from the University Grants Committee itself, entitled "University Developments, 1935–1947" (see *Nature*, 163, 154; 1949).

Sir Walter's book is, indeed, a natural complement to that report. With the single exception of the question of numbers, which bears so vitally on the maintenance of standards, Sir Walter probes deeply into all the issues raised in that report and into others less readily discussed in an official report. Broadly, the book is based on the conviction that much that ails universities to-day is closely connected with what is wrong with the whole world, and that the malady is rooted chiefly in the underlying assumptions, largely unconscious, by which their life and work are determined. The older universities, Sir Walter points out, grew up in a world very unlike our own. Their traditional assumptions are, to some extent, outdated and, in practice, discarded; but no agreement can be found on the answer to the questions how far this process should continue and what alternative assumptions should take the place of the old. The debate of the last ten years has revealed discord as well as vagueness concerning the *raison d'être* of universities and the standards to which they should pay allegiance and by which their policies must ultimately be judged.

Thus far Sir Walter would doubtless command general agreement; but he admits frankly that his argument and conclusions will only be thoroughly convincing to those who accept certain assumptions on which that argument is based. He postulates first that we are living in an age of exceptional crisis and that the issue depends chiefly on the human factor—in the last resort on the beliefs and sentiments which really govern the actions of men. These beliefs are in flux, and our society has lost direction.

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* The Crisis in the University. By Sir Walter Moberly. (Published for the Christian Frontier Council.) Pp. 316. (London: S. C. M. Press, Ltd., 1949.) 15*s*. net.

The clue to reconstruction, he postulates, is to be found within our own tradition, and in that tradition the Christian element is vital, although the whole tradition needs to be purged and enriched.

The ability and willingness of the universities to respond to the challenge of the stupendous intellectual task with which, on these assumptions, our generation is confronted, are Sir Walter's primary concern. With these postulates in mind in successive chapters, he reviews the changing conceptions of the task of a university, and some causes of our present discontent. What he regards as the spurious remedies of scientific humanism and classical humanism are then examined and dismissed as inadequate—the latter, perhaps, a trifle too naïvely. Sir Walter then examines the fundamental questions of the aims and basis of a university, and ranges widely and with penetration over the varied and complex problems involved in academic freedom and integration, the content of studies, corporate life, the place of the university in the world, the task of Christians in a modern university and the role of a theological faculty.

This penetrating analysis thus covers the whole field of the functions and work of the universities. But the fundamental issues are always kept firmly in mind; there is no straying into irrelevancies, although Sir Walter writes with wisdom and discernment on many secondary questions as well as on his main theme. If the question of numbers is eschewed it is deliberate, because the number of students, and even what faculties should be maintained, are of secondary importance to that of determining the prime purpose of a university and what the community should expect to find in the new graduate. With this discernment go a balance of judgment, a persuasiveness and charm and a reasonableness that will commend the book even to those least disposed to accept the author's premises in their entirety.

Summarizing the results of this analysis and argument in a final chapter, Sir Walter suggests that while in technical advances the universities are showing the way, only to a slight extent are they protagonists in the transmutation of values. No accepted ideal has replaced the traditional one of training students for leadership in a stratified society now disappearing and in which we no longer believe. The universities have no agreed criteria by which to assess their policies, organisation, teaching methods and the forms of their communal life; and the crisis in the universities of which Sir Walter writes arises out of the contrast between the need of the time and present academic inhibitions and disabilities.

The accuracy of Sir Walter's diagnosis has since been emphasized in the presidential address of Lord Southway to the Classical Association delivered in Manchester on April 21. Lord Southway directed attention to the dwindling number in recent years of those distinguishing themselves in the Classical Tripos at Cambridge or in the School of Literæ Humaniores at Oxford who have found their way into political life or have attained political eminence. In this respect they are greatly outnumbered by the natural scientists, economists, psychologists, technologists and other kinds of experts. For all its priceless value, a higher classical education appears to b making little direct contribution to the daily busines of the modern world.

What needs to be remembered is that in the la two generations the centres of political power hav shifted, and leadership in Britain is no longer co fined to such fields as the Church, the professions, th Civil Service and the armed forces of the Crown. A the same time, there is little evidence that the classical scholar is entering new fields, such as the trade union movement, in which clear thinking and selfless leadership with the classical qualities o restraint and toleration are no less important than for example, in the Church. The very fact that the universities are not ostensibly providing leaders o the requisite calibre in all the important fields o modern life should impel teachers and administrators to think deeply about the issues to which Sir Walter directs their attention.

Sir Walter will doubtless feel recompensed if his book awakens university teachers and administrators to greater concern about these issues, for even the Christian revival for which he himself looks must comprise, as he recognizes, not only recovery but also an element of discovery. The positive policy he advocates starts with the removal of all inhibition on discussion of the vital questions of the day. The university must be a battle-ground where the real intellectual issues of our time are fought out, and their protagonists are confronted with one another In such wrestlings the university must stimulate the characteristic academic excellencies of precision, comprehensiveness and candour, and the penetration which discerns the principles underlying practical disagreements. Moreover, such debates must be conducted at the level at which our several basic acceptances begin to diverge. This demands the restoration of communications between the isolated mental worlds which different groups have come to inhabit.

Even thus far, Sir Walter will doubtless stimulate much discussion; and to adopt his proposals might well shock the governing bodies of certain universities as Bruce Truscot's books have indicated. But S Walter is emphatic that there is a limit to neutrality. There are issues so fundamental that real neutrality is impossible. Irrespective of internal differences, a university as a whole must stand for such basic academic values as a passion for truth, thoroughness in pursuing it to the bitter end, a delicate precision in analysis, a judicial temper, a willingness to learn from all quarters and an uncompromising insistence on freedom of utterance. There are also other values common to the whole community in which the university is set: for British universities these include recognition of an absolute moral obligation, an ingrained respect for law and order and an unshakable conviction that 'people matter'.

Beyond this, Sir Walter insists that in the university it is necessary constantly to explore and probe su values and to discover how far they are genuine a coherent. "It is the special vocation of the universit to think things out and to trace particular trut back to the principles on which they rest." Wh however, he urges that a university should not be colourless or merely neutral on major issues, but should honestly avow the scheme of values by which he ordering of its life and studies is determined, his ontention that these values can and should be ncreasingly Christian values does not lead him to claim for the Christian in the university more than the role of a creative minority.

This brief summary of Sir Walter's main argument may show the wide field he traverses, although it cannot do adequate justice to the persuasiveness with which it is presented or its lucidity and cogency. The argument also flows into numerous other questions, such as the regional responsibilities of a university, in which he firmly believes, the autonomy of a university and its relation to the State. A word must, however, be said of his treatment of the question of studies in relation to the equipment of a student to choose ends and recognize values so as to live his life more purposefully; this is necessary to show that what Sir Walter advocates is not that the universities should train their students with any particular philosophy of life—even a Christian philosophy—but that the students should be helped to formulate their own, and given the best guidance as to where the most effective help may be found.

Sir Walter's solution to the problem of combining general with occupational education involves breaking down the present isolation of subjects and departments, not only giving more attention to fields in which they overlap but also bringing different disciplines to bear on the same problem. The overloading of curricula must be ruthlessly assailed, and for members of staff a new balance between teaching and research must be found. A healthy insistence on discovery and original thought must not, he insists, be over-stressed to the virtual exclusion of any real intimacy between teachers and pupils, while customary methods of teaching and of testing must be reconsidered.

In discussing the way in which the university could dapt and [illegible] aristocratic tradition inernally [illegible] ouches on the question of electi[illegible] izes even more explicitly han [illegible] s Committee in its report that the [illegible] e, a place for others than those who [illegible] vards or scholarships, and he quotes pertinently from Lord Balfour's experience at Cambridge. Sir Walter shares the belief that A. Liddell Hart proclaimed in a recent broadcast on the Third Programme of the B.B.C.: "The closed shop in any form is the very antithesis of a living university". Liddell Hart went on to suggest that the Free University of Berlin may be worth watching "to see whether the German tradition of learning can be freely reconciled with the American development of the community centre, whether the German belief in an élite can be joined to the American faith in ever-widening opportunities".

Sir Walter has made a contribution to the discussion on the place and future of the university which is important not only in its British setting but also in the wider world context with which the nited Nations Educational, Cultural and Scientific Organisation is already concerned. If he raises many controversial issues, he asks many questions to which answers must assuredly be found, and not least he challenges the complacency with which some popular ideas of the functions of a university and of university practice are accepted. The book is more constructive than Ortega y Gasset's "Mission of the University", which although equally challenging was more limited in scope; and Sir Walter is as uncompromising as is Sir Charles Grant Robertson in his belief that the universities must face the issue of religion if they are to become real laboratories and power-houses of spiritual and moral efficiency.

KINEMATIC RELATIVITY

Kinematic Relativity

A Sequel to "Relativity, Gravitation and World Structure". By E. A. Milne. (International Series of Monographs on Physics.) Pp. vii+238. (Oxford: Clarendon Press; London: Oxford University Press.) 25*s*. net.

THIS book contains a systematized account of the developments in kinematic relativity since the publication in 1935 of the author's "Relativity, Gravitation and World Structure". It is complete in itself, containing a sufficient account of the earlier work to enable it to be read independently.

To express opinions about the merits of kinematic relativity is to risk entering a domain of controversy relatively unfamiliar to the pure mathematician. Yet it is appropriate that the book should be noticed by pure mathematicians, to whom, as the author notes, it may have a greater appeal than to the "hard-headed experimental physicist". I have personally found it very attractive, with its clarity of statement, its careful attention to definitions and its logical development; but it is this same abstract approach that makes the theory unattractive to the empirically minded, and partly accounts, no doubt, for its incomplete popularity. Kinematic relativity has been the object of much criticism, some based apparently upon prejudice and some upon misconceptions of Milne's purpose and point of view; but it has fortunately also received a share of the respectful and dispassionate criticism due to a striking and powerfully argued theory.

Milne maintains that kinematic relativity is self-consistent, and that, being so, it is on a footing similar to that of the various systems of geometry, the acceptance of which bears no relation to their applicability to the external world. That may be so: but it is as a cosmological theory, and not as a mathematical *tour de force*, that it will almost certainly be judged, however great may be its intrinsic merits. Those merits are considerable, for, if the book is nothing else, it is a work of art, with a sense of intellectual adventure running through it.

Kinematic relativity is not concerned with the construction of different sorts of universes suitable for the representation of different phenomena, and so has no counterpart of the various worlds (flat, Schwarzschild, expanding, etc.) of general relativity. It is concerned with the construction of a single universe, idealized in the sense of being 'smoothed out', but possessing the main features of the physical world. It is the single stage upon which the whole physical drama is to be played, and Mach's principle (that the contents of the universe determine its laws) is one of its corner stones.

The book is divided into four parts, dealing respectively with kinematics, dynamics, gravitation and electrodynamics. Much of the first part, which contains an account of the now almost classic theories of time-keeping and equivalence, is undoubtedly of lasting value, whatever the ultimate fate of the theory as a whole, for it makes a notable contribution to our understanding of the meaning of time in physics. From it emerges the basic picture of the kinematic universe, a universe populated homogeneously by equivalent particle-observers possessing a common system of time-keeping, their congruent clocks being capable of agreed regraduations. This idea of obtaining alternative descriptions of the universe by the adoption of different time-scales is of profound interest, and has a significance more fundamental than the changes of time co-ordinates (usually physically undefined) permitted in general relativity. The set of particle-observers (the 'substratum') is the idealized representative in Milne's abstract world of the system of galaxies of the actual universe.

The passage from kinematics to dynamics is claimed, remarkably but not unreasonably, to be the only logical possibility, no appeal being made to empirical physical laws. The rest of the book abounds in striking results and bold assertions, most of them already known to relativists through their earlier publication in research papers. Only brief mention of a few of them can be made here. Milne deduces, for example, that the gravitational γ and Planck's *h* vary with the epoch; he claims to have resolved Hubble's difficulties in interpreting the red-shifts; he assumes no electron spin, his electrons being point-singularities, but deduces for them an effective radius equal to that of the classical electron; and he obtains, perhaps most remarkably of all, an equation for the spiral arm of a nebula, which possesses the unexpected property of turning back on itself after a certain number of convolutions, thereby suggesting a 'trail'. How far his results (assuming them applicable to the actual universe) are susceptible of observational test, I am not competent to say: nor do I feel able to venture opinions about the philosophical implications of his ideas. But I am sure that the work is too well reasoned to be lightly dismissed, and I would recommend it to the serious attention of physicists as well as to mathematicians.

H. S. RUSE

FARM MACHINERY

Machines for the Farm, Ranch and Plantation

By Arthur W. Turner and Elmer J. Johnson. Pp. xvi+793. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

THE authors of this book have set themselves the difficult task of providing information on the host of different machines used in American agriculture. They have made a good start by adopting an intelligent system of classification of the equipment under the six headings of seedbed preparation machines, crop planting machines, crop tillage machines, harvest and harvest handling machines, mechanical power and transportation machines, and general service machines and barn and produce equipment. The chapters are well set out with clear headings to the sections and sub-sections, a wealth of good illustrations and with a useful summary at the end of each; in fact, the plans and foundations are excellent. It is unfortunate that the structure built on those foundations is not nearly so good.

Each machine is dealt with from three aspects—its selection, its operation and servicing, and its reconditioning. The part dealing with selection consists mainly of a description of the different available versions of each machine and of the extra fittings or attachments that go with it. The direct advice that the authors give to anyone faced with the job of choosing a machine is usually confined to a few brief and relatively uninformative sentences. For example, their advice to someone choosing a field cultivator is to "Select a size to match the power and with teeth or sweeps best suited for the purpose used". They do not, however, give the reader any idea of the amount of power that field cultivators need, nor do they describe the performance or applications of the various patterns of teeth or sweeps. The authors have, in fact, dodged one of the major problems facing farmers to-day—that of finding a matching set of equipment made up of units that will work smoothly together, and will allow all the farming operations throughout the year to be carried on with a constant and minimum amount of labour. The advice given on the operation, servicing and reconditioning of farm machinery is more complete. The practical farmer and tractor driver would probably have preferred, in addition to the details of setting and maintenance, more information than is given on the technique of working the various machines in the field, while the farm mechanic might ask for more practical instructions on the overhaul and repair of the machines described.

This book, which at a first glance appears to be so useful to everyone connected with agriculture, is disappointing. It gives a very good picture of the range of farm machinery available in the United States, and will be of more use to students and lecturers than to farmers and mechanics, or to those engaged in research in [illegible] of agricultural engineering.

[illegible] HAWKINS

CHEMICAL ES[illegible] OF WA[illegible]

Aquametry

Application of the Karl Fischer Reagent to Quantitative Analyses involving Water. By John Mitchell, Jr., and Dr. Donald Milton Smith. (Chemical Analysis, a Series of Monographs on Analytical Chemistry and its Applications, Vol. 5.) Pp. xi+444. (New York and London: Interscience Publishers, Inc., 1948.) 48*s*.

IN the whole area of chemical analysis few estimations are more important than that of moisture, and few in the past have received such casual treatment. That a volume of this size and character should be devoted substantially to one chemical method of estimating water is welcome evidence of the growing importance attached nowadays to precision in this field. The pendulum may, indeed have swung a little too far; occasionally in this book